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EDITORIAL

National Planning and Forestry

IT IS imagined by many who do not stop to think that the proposal of a controlled economy for the United tates is a novelty. Nothing could be arther from the truth. The whole ecoomic and political history of the couny illustrates controlled and directed evelopment.

The first "plantations" of English setlers were not the result of a spontaneous verseas migration, nor of private enterrise disconnected from governmental olicy, but were engineered as a cordinated part of Great Britain's effort increase her national power and ealth. Consistently, English control of e political and economic development f the expanding settlements sought to ake them as serviceable as possible to e mother country, in accordance with e accepted mercantile theory which overned state economic policy.

The colonies revolted against this conol; but when independence was achieved, e question arose, whither next? On at there was great division. Economic terests established the lines of cleavage. he contest was not for freedom from ntrol, but concerned whose interests ould dominate.

The framers of the Constitution desed a form of government largely dermined by economic considerations. It set up controls highly distasteful to a large part of the population, as adverse to their interests, and was with difficulty adopted; had it been submitted to a popular vote, with the suffrage unlimited by property qualifications, it could not have gone through.

But fashioning and launching the ship of state left the question of whither still largely open. Washington was no more than inaugurated President when contention arose as to the form of economic development to be pursued under the Constitution. The issues involved divided the Nation into political parties, and eventually into the opposing armed forces of the Civil War.

Jefferson and Hamilton—both in Washington's cabinet—differed radically and violently on the right course. Jefferson wanted a rural Nation, with governmental policies favoring the agricultural interest, with diffused wealth, decentralized political and financial power, and no federal course of action designed to build up domestic manufactures, great cities of landless laborers, and American shipping engaged in foreign commerce with its entanglements. Hamilton wanted a protective tariff in aid of industrialization, centralized banking and financial control favorable to the development of business and the accumulation of capital,

ship subsidies, and the like. Each sought to have the course charted in the direction of what he held to be the national interest, for each believed that governmental policy should guide national economic development and govern its character; but their conception of what was in the national interest—of what kind of a country they wanted to see emerge—were irreconcilably different.

Jefferson represented less a Southern than a Western point of view—the frontier spirit. After he became President he put through the Louisiana purchase, despite his belief that his course was unsanctioned by the Constitution, to afford more room for the upbuilding of a great agricultural Nation, as well as to assure command of the Mississippi River for the downward passage of the agricultural products of its valley. The Federalists opposed ratification of the treaty. They feared the shift of political power which the entry into the Union of western states would bring; they feared the enlargement of the agricultural interest; they feared increased taxes to pay the purchase cost; they feared the loss of laborers through migration, and lowered values of land already owned. As usual when economic interests are adversely affected, or thought to be, they became strict constructionists of the Constitution—just as the strict constructionists again and again changed their song when economic expediency called the tune. But the Federalist opposition was outvoted; and the "worthless wilderness" thus brought under the flag enormously augmented the problems of public domain policy created by the state cessions of their claims to western territory a few years earlier.

The public domain, subsequently increased still further by the acquisition of Florida, by additions wrung from Mexico, and by treaty with England, was a vast source of wealth, in public lands. How should it be used? Many were the proposals. There had to be a nationa plan, whether or no; a gauging of prob able consequences, and a choice amon the various courses open.

One view was that the public domai should be handled with first considera tion to its potential value as a source c revenue to the federal treasury and means of discharging federal obligation to those who had fought in the Revolu tionary War. The country was loade down with what seemed in those day an enormous debt. Another view wa that settlement should be promoted b opening a wide door for migration through lenient terms. In time the deb was wiped out, mainly through receipt from the sale of the public lands; bu that did not terminate the plan of re quiring settlers to purchase. Not unti 1862 was the Homestead Act passed The same year saw the first great lan grant voted for the construction of transcontinental railway. The national eco nomic policy for the public domain wa fixed; its lodestar was to be developmen of the West, as a country of free oppor tunity for the small man, and with bounti ful aid to education, state public insti tutions, and railroad building, essentia for opening up the resources. On th whole, the Jeffersonian viewpoint con quered, so far as the intentions of th laws were concerned.

When the policy of National Fores ownership and administration was en tered upon, it was not a revolutionar departure from a previous laissez-fair theory but a new application of th fundamental principle that one of th functions of government is to promot the general welfare. The policy of dis posal of the public domain under th limitations of the general land laws wa adopted as a means to the end of a par ticular form of economy, based on smal proprietorship; the range livestock in terests vainly sought laws that would dispose of the land to them in tracts ade

quate for their industry, and permit them to turn back the tide of the settlers. Once it came to be clearly seen that forest preservation on the western mountains was necessary to protect essential water supplies and furnish permanent timber supplies, the western National Forest policy won widespread western approval because in fundamental accord with the broad purpose of federal land policies in the West; policies intended to be favorable to the settler, the home-maker, the small man, and agriculture, and opposed to monopolistic private control of economic development.

Yet the establishment of the National Forests opened a new chapter in the history of planned public control. It involved a recognition that unrestricted freedom of the private landowner to pursue the course most advantageous to him may be economically injurious to the public. Out of that sprang the conservation movement. Its essence is the conception of a national interest, extending far into the future, in the kind and character of use to which land is subjected.

That the conservation idea was an outgrowth of forestry is readily understandable. For forestry absolutely requires the long look ahead. No other form of enterprise is concerned with production for the use of another generation. Knowing that time brings unforeseeable changes, the forester must nevertheless contrive his operations on the basis of the far distant future. That the crop which he nurtures may turn out to be no longer what the market is ready to absorb when it reaches maturity he has to admit; but, for better or for worse, he must make the best forecast that he can, and work out his plan accordingly.

Time and better knowledge have already invalidated some of the forecasts on which rested the earliest forest-conservation planning, in the field of public policy. The trends in wood use, in population increase, and in agricultural land requirements are examples. Foresters should be the last to draw the conclusion that therefore any attempt at public direction of the economic course of development is futile. The plain fact of the matter is that in any case it is bound to be directed. The powers of government will continue to be used, as they always have been used, to serve economic interests; to steer the course in one direction or another; to determine what kind of a country we and our children shall live in. The only question is as to whether the planning is to be aimed at furtherance of a true and wisely conceived national interest, or at the furtherance of more limited and selfish objectives.

THE PROPOSED MOUNT OLYMPUS NATIONAL PARK

By C. J. BUCK

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THE introduction by Representative Wallgren of H. R. 7086, which would create a wilderness National Park on the Olympic Peninsula, brings boldly into the open an issue on a fundamental principle of land management. The bill would provide that "the Mount Olympus National Park shall be permanently reserved as a wilderness, and no development of the project or plan for the entertainment of visitors shall be undertaken which will interfere with the preservation intact of unique flora and fauna and the essential primitive natural conditions now prevailing in the area."

The proposal is to allocate by statute 667,089 acres of forest and mountain land to a single use, without a thorough attempt to demonstrate that there is a national or even a local need for such statutory dedication of valuable public resources.

The proposal is an illustration of action with insufficient factual background. The great value and variety of the resources involved alone would indicate the need for flexible management. It has been demonstrated repeatedly that the laissez-faire policy of land management leads only to disaster. In this region, with its complex biological associations, some active, progressive form of management must be applied, else the very forces which have created will eventually destroy. The elk, already a problem here, if not controlled will eventually destroy their range and deteriorate into another starving, diseased herd. The cougar, the bear, the deer, and all the rest have their place; yet if any one species is allowed to dominate, others will be lost. Sound land management indicates use as a means of control over a large part of the area.

The dominant and sustaining features of this area are of course the forest and the picturesque rugged scenery. In addition to the 2,472,788,000 board feet of commercially operative timber within the Monument, the Wallgren Bill would definitely withdraw 13,624,431,000 board feet more of commercially operative timber from all forms of use other than the recreational and inspirational. Also, some 636,950,000 board feet on intermingled state and private land would be involved, making a total withdrawal of 16,734,169,000 board feet of commercially operative timber.

Were this area the only remaining stand of virgin timber in the Northwest, or were it the outstanding example of superb scenic and recreational values, then perhaps the need for statutory allocation to a single purpose could be conceded without actual scientific determination of economic need. If this area were the only remaining primitive or wilderness area in the Northwest, again there would possibly be little argument as to its essential value.

However, the fact is that in the Olympic National Monument alone, before the Wallgren Bill was introduced, there were nearly $3\frac{1}{4}$ billion feet of virgin timber, of which nearly $2\frac{1}{2}$ billion feet are commercially operative, definitely preserved for its aesthetic value within the Monument alone. This virgin timber within the Monument is probably the cream of the timber stands on the Olympic Peninsula, in so far as appeal to the recreationist is concerned. Some of the stands

near the stream heads greatly surpass in variety of species the lower areas proposed for inclusion in the Park.

As a primitive or wilderness area, the Olympic proposal is dwarfed by the fact that already in the National Forests of the state of Washington there are 1,911,-212 acres set aside for preservation in their natural state. In the five states of Washington, Oregon, Idaho, Montana, and California there is a total of 7,822,-106 acres with this same primitive or wilderness area designation. These areas contain 13,346,499,000 board feet of timber. True, these designations are not statutory, yet they represent the best judgment of men long in public service of the justifiable needs of the public now and as far into the future as years of experience and thought can penetrate.

Again, from a scenic and recreational standpoint, the Olympic area is at least equalled if not surpassed in many places, even in the state of Washington. Certain it is that Mount Saint Helens with Spirit Lake, Glacier Peak and Lake Chelan, and the Mount Baker region are not measurably surpassed in scenic, recreational, inspirational, and certainly not in wilderness values by the Olympics.

To those who have traveled the Olympics it is apparent that only a very small part of the timbered area can be used by the recreationist, and that part largely along the trails and roads. A few hardy individuals may back-pack off the trails and secure a measure of satisfaction by fighting their way through the almost semitropical jungle of undergrowth and down timber. We know, however, from our experience that the vast majority of recreation seekers will stick to the roads, a far lesser number will travel the trails and high alpine ridges, and only an occasional individual will take to the trackless wilderness.

Those who have traveled the Olympics know that not much over two months of each year is sufficiently free from fog and rain to permit enjoyment of the recreational values. Fog and rain occur intermittently even during the summer months.

The administration of the Olympics is primarily a problem in forest land management. Professional foresters should, by reason of their training and experience, be most qualified to take the leadership in the solution of this problem. They will, however, need coworkers on the biological problems and in recreation and other varied use problems.

The gross area of the Olympic National Forest, including the National Monument, is 1,559,721 acres. The area of the Monument is 298,730 acres. The area proposed for conversion from National Forest status to a National Park is 353,060 acres. The total timber volume within the National Forest boundary is estimated at 37,040,000,000 board feet, of which 17,434,169,000 board feet is proposed for inclusion within the Park. The potential sustained yield of the Olympic National Forest, exclusive of the Monument, is 340,000,000 board feet, and of the Monument 30,000,000. The state of Washington's Sustained Yield Forest No. 1, adjoining the Olympic, has 94,000,000, making a total estimated ultimately attainable annual sustained yield of 464,000,000 board feet. This would support a population of some 39,000 persons.

The sustained annual production of the lands proposed for inclusion within the Park is: within the Monument, 30,000,000 board feet, and other National Forest land, 162,000,000; a total of 192,000,-000 board feet. This is exclusive of the 636,950,000 board feet of timber on intermingled state and private land. The proposed Park would include 43.3 per cent of the total estimated timber volume within the exterior boundaries of the Olympic National Forest, 41.3 per cent of the total sustained annual yield capacity of these lands, and 50 per cent of

the total estimated capacity of this forest to provide permanent employment. This timber, if used, would permanently support around 19,000 persons. These concrete facts can not be waved aside nor cancelled by the vague and unsupported statements that increased travel due to the advertising value of the name National Park will compensate for the loss of the industry and employment which otherwise might exist through the development and use of the timber resources.

The main timbered portion of the National Forest lands proposed for designation as a National Park, if kept available for operation on a sustained-yield basis, will constitute a very great factor in securing sustained-yield management on a large acreage of adjoining state and privately owned land in addition to the Clearwater State Forest, which is now under this form of management.

For over thirty years this area has been under the jurisdiction of the Forest Service, except that three years ago the National Monument area was transferred to the administration of the National Park Service by executive order. Management plans based on actual inventory of the resources have been made and revised throughout this time. These plans have taken all the resources into account. Recreation surveys are of record as early as 1910, and the plans based thereon have kept pace with public needs. The present recreation plan, usually referred to as the "Cleator Plan", approved June 10, 1929, provides generous timber reservations where such reservations are needed to protect the scenic and inspirational values. It sets forth in detail the various uses which will be allowed, and specifically states what uses will be barred. The so-called "Cleator Plan" makes provision for all recreational uses, from the highly developed campground and summer-home colony to the rough, rugged, untouched primitive area.

This plan originally set aside 134,240 acres as a primitive area and anothe large unit of 316,960 acres as a hig mountain recreation area, including lan both inside and outside the Nationa Monument. Within these areas trail trav and rough conveniences were projecte and means were taken to protect th area from any considerable road de velopment or mechanized means of trav and from highly developed resort estab lishments not compatible with the exis ing wilderness values. It definitel planned, however, for over-night accom modations at reasonable intervals at rusti chalets. For leisurely trail trips to th many scenic points, pack-horse guid depots were provided for, some of whic are at present functioning. In the lowe portions of the forest the plan provide for protection of timber border strip along the highways, and for the preserva tion of timber about more importan recreation centers, as at Quinault Lak and Lake Crescent. It provided fo automobile camp grounds and summe homes and resorts at such highway loca tions, and scores of summer homes an one of the best resorts in the Northwe are now being enjoyed at these planne locations. The plan provided for stu roads to the exterior boundaries of th area, so that people might easily reac the interior of the primitive and recrea tion areas by horse and foot travel. Th many known diverse forms of recreatio use were provided for and correlate with the use of the other resources.

Just recently, or on July 3, 1936, th Acting Secretary of Agriculture made definite primitive area classification o 238,930 acres outside the Olympic Na tional Monument, carrying 2,748,000,00 board feet of virgin timber. The prov sions of this latest report make the pla of management set forth mandatory upo the Forest Service, and allow chang only with the written approval of th Secretary of Agriculture. This plan o management presents a balancing of use

in accordance with the demonstrated values, and does not cut the economic heart out of the Olympic Peninsula. The combined Primitive Area and National Monument include the best of the inspirational and scenic values and approximately 5,700,000,000 board feet of merchantable virgin timber.

The National Monument and the recent and formally established Olympic Primitive Area combined, an area of 537,660 acres, contain generous samples of heavy virgin timber stands typical of the region, and so located as to be most usable to the recreationist, whether he be of the vast majority who use only the trails and open ridges or whether he be the exponent of the Daniel Boone type of living. These two areas should be managed jointly along the lines required by the "Cleator plan". The withdrawal of a larger area or total timber volume as contemplated by the Wallgren Bill of 13,624,431,000 board feet is unjustified and without basis of public need or welfare. The 5,700,000,000 board feet will in my judgment serve all legitimate and conceivable wilderness and natural area needs for the future.

To sum up the situation briefly: The Forest Service has administered the area, including the Monument, for over 30 years. It has been progressively coordinating the uses through plans of record based on factual inventories and made by men of long experience not only in forestry but also in forest recreation. Recognition has been given the aesthetic and inspirational value of virgin timber as against the purely commercial value.

The Forest Service has long recognized the desirability of handling certain portions of the area as a natural wilderness or primitive area, even outside the National Monument. Administrative action to protect the known values has been taken, and the balanced plan now existing provides ample protection of the recreational values without unduly endangering the established economy of industry dependent on timber and its conversion.

The Olympic National Monument, which was under the jurisdiction of the Forest Service until June 10, 1933, when it was turned over to the National Park Service by Executive Order, is geographically the center of the area and so integrally a part of the recreation and wildlife problems involved in surrounding National Forest land that it should be returned to Forest Service administration.

SOME PREFERENCES OF FOREST VISITORS

By F. G. CLARK

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WHO are visitors in the National Forests? Where do they come from? What do they expect and what are their demands?

These and other questions have at least been partly answered in 300 questionnaires returned from forest visitors of the summer of 1935 in Region 1 of the Forest Service.

The return comprised 30 per cent of all the questionnaires sent out. Every tenth name was arbitrarily taken from a list ten thousand names of visitors who had registered at camp grounds or checking stations. This undoubtedly gives a fair cross-section of the visitors using the forests for camping purposes. Their replies should therefore be an indication of the desires of the statistical populations they represent.

Where did the people come from? It was found that 49 per cent of them came from towns of less than 5,000 population. The majority of this 49 per cent were rural visitors. In many instances it was evident from the occupations of the visitors that the town was only a post office address. Towns from 5,000 to 10,000 furnished 25.4 per cent; those from 10,000 to 15,000, 13 per cent; 15,000 to 20,000, only 3 per cent; and those of 20,000 or over, 9.6 per cent. The major portion (no percentage taken) of the visitors came from towns adjacent to the National Forests, seeming to indicate that local people are the largest users of these public playgrounds. This may account in part for the large number of visitors from the smaller towns, since most of the populations of the states in the Northern Rocky Mountain Region are rural.

The questionaires were divided betwee those using the Forests in the easter part of the Region and those in the wes ern part. This, however, did not sho any marked difference either in use c demand.

The heaviest users are the busine men—28 per cent, followed by the pro fessional group (teachers, doctors, law yers) with over 17 per cent.

Skilled labor—mechanics, painters, et —furnish nearly 14 per cent of th recreational users and day laborers near 11 per cent. Surprisingly, nearly 10 pe cent of the laborers came from th ranches and farms. Railroad men an government employees—largely of th clerical class—furnish 13 per cent, abou evenly divided.

What were the visitors doing? Thirt per cent were fishing, and 25 per cen sought rest and relaxation. Berry picker swimmers, hunters, nature lovers, stop overs, and those with no definite obje tive furnished, in the order named, fro 5 per cent to nearly 10 per cent of th users. Hunters made up 9 per cent— relatively small number compared to th fishermen and the "relaxers."

What do these visitors demand in th way of accommodation in camp grounds To the question: "Do you think ther should be more National Forest camps?" 83 per cent voted "yes", 10 per cent "no and 7 per cent voiced no opinion.

With reference to individual or exclu sive camp grounds, 57 per cent were i favor; 25 per cent wanted them *close* t others; and 18 per cent were neutra One may wonder how many of this i indifferent 18 per cent were those in dependent souls who prefer to make the

own camp grounds as they need them. This was adequately answered by the question: "Do you prefer an undeveloped camping spot to one provided with stoves and tables?" Eighty-one per cent wanted the tables and stoves, 8 per cent wanted undeveloped grounds, and 11 per cent were indifferent. These ratios seem to be borne out in regard to community picnic areas and to individual party picnic spots, the percentage for individual picnic grounds being 54 per cent and for community 30 per cent, while the indifferent ones are nearly 16 per cent.

However, in the matter of timber growth 64 per cent preferred open grove, while 26 per cent preferred timber and underbrush. Ten per cent of this group expressed no preference in the matter.

In summing up this matter of camp grounds in relation to the present Forest Service policy, the overwhelming consensus of the visitors indicates that the policy of constructing more camp grounds is sound—that the ratio of individual to grouped camp grounds should be a little greater than two to one. In the matter of community picnic grounds, however, the ratio is only 1.8 to 1. But this difference is not sufficient to warrant a change in the ratio. The inherent desire of those wishing the privacy and freedom of individual camping places is also carried over to the picnic grounds. As indicated by this vote, the majority of the campers or picnickers desire privacy. Perhaps a larger number of the gregarious campers would prefer privacy if they were familiar with camp life and the forests, and therefore, more self-reliant.

"Are the camps easily found from the travel routes, i.e., properly marked?" Nearly 80 per cent voted "yes"; 14 per cent "no"; and 7 per cent gave no indication. This apparently shows holes in the sign plan that need plugging,—perhaps a ranger district here and there, or maybe an entire Forest. This is borne out by the question relative to more directional and informational signs along the roads. Eighty-four per cent wanted more signs, while 10 per cent voted "no", and the reliant, self-sufficient souls in this case numbered only 6 per cent.

In reference to informational folders, namely, maps showing road information and other data of the forest, 94 per cent want them; 2 per cent did not; while the indifferent visitors made up only 4 per cent. This is perhaps due to the education of the auto-service stations and the chambers of commerce which furnish information and other data of this character free of charge. The public has been educated to expect this—no doubt one of the best mediums of education.

It is interesting to note the taste displayed in the matter of camp ground development. Nearly 80 per cent showed the excellent taste of wishing to preserve the natural beauty as far as possible in the development, several being quite radical in this respect. Eight per cent had the city-park complex and wanted play grounds for the kids. Nearly 13 per cent were neutral or indifferent to this phase of development.

The primitive area policy was strongly sustained by a vote of 79 per cent for the present policy and 18 per cent against. Less than 4 per cent were neutral. This is one of the smallest neutral groups on any question, indicating that the subject of primitive areas has been thoroughly discussed by the public, and opinions for and against have been fixed.

What type of stove is wanted? Seventy-nine per cent want a solid plate top; 14 per cent the grill plate; while 7 per cent did not express any preference. Forty-two per cent carried their own stoves; 53 per cent did not; while 5 per cent didn't answer. On the other hand, while 93 per cent of the visitors wanted stoves to cook on, 81 per cent wanted camp fires in addition; 12 per cent did not, and 7 per cent were neutral.

This follows the present policy of

camp-site development quite closely, but emphasizes the continuance of providing both stoves and fire places. The community fireplace may solve this in part, but the percentage of those wishing exclusive fires will no doubt follow closely the figure given for individual exclusive camp grounds. On several occasions the author has noticed at the grouped camp grounds all the tables collected at one point, excluding other campers who might wish to use the grounds. The present location of the tables at camp grounds is held very satisfactory, the favorable vote being 88 per cent against 5 per cent. The policy of setting tables permanently at camp grounds is a sound one. This prohibits the gratifying of whims of a minority, often at considerable inconvenience to the majority.

In the matter of the location and construction of toilets, 91 per cent were well satisfied with the present set up, and only 4 per cent were not—a very high percentage of pleased visitors.

In the matter of the use and location of garbage pits, 95 per cent did not want them any closer to the stoves and tables, while the negative vote of 2 per cent may well be disregarded. Eighty-seven per cent found it convenient to burn refuse and papers in the stove, while 10 per cent did not. Apparently there is still some demand for an incinerator at camp grounds.

The wood and water supplies seem to have been satisfactory to the great majority of the visitors. The negative vote for the wood went to nearly 11 per cent, most of the criticism against the woodpile being the size of the wood (in the round), necessitating the use of a crosscut saw, which very few visitors carry. Otherwise, the favorable vote was over 80 per cent in both cases. The author's comment on the size of the wood is this: If the wood were of a convenient size to use without much effort, there would be a tendency toward wasteful usage. And since the camper is out for recreation and exercise, little harm can result from his having to "bearer off" the amount of fuel that he may need.

Either the public has become educated in the care of camp grounds or they are well policed by the guard force, because 82 per cent of the visitors state the grounds were clean when they entered them. Only 8 per cent found littered grounds. This can only be credited to the constant education of the public by the field force. They are doing a marvelous job. With a constantly increasing new crop of visitors, they unfortunately can't discontinue this good work.

Sixty-two per cent of the campers use tents, to which may be added 1.3 per cent for those with house-trailers. Eight per cent are planning on getting them, but 84 per cent are definitely decided against them. Seventeen per cent use auto-trailers, 79 per cent do not.

While house-trailers do not appear to be popular with this particular group of users, other statistics and empirical observations show that the popularity of house-trailers is on the increase. Provision should be made for them in future plans of camp ground development.

As to being visited by forest officers while in camp: only 45 per cent were visited; 51 per cent were not; and 5 per cent did not reply. Perhaps a little more effort could be expended at this point, especially when 73 per cent have no objection to the visit, and in the majority of cases would welcome it. Only 8 per cent voted against this—an attitude that was perhaps engendered by the wrong approach of inexperienced guards. Nineteen per cent were neutral. The question was a little ambiguous; hence the large number of neutral votes.

In summation, the replies to the questionnaire indicate that the recreational policy of the Forest Service, as exemplified in Region One, in so far as the campers and visitors are concerned is

pleasing to the great majority. In general, the comments were extremely favorable. The consensus was in favor of more camps, better signs indicating where they are, and for the most part, better roads leading to them. The sentiment was very favorable in all of these comments toward the Forest Service and the recreational policy it has pursued. There seems to be a strong feeling toward more intensive control throughout the Forest in the matter of game and fire protection, as well as other police regulations. Sentiment expressed in the questionnaires was also extremely unfavorable toward the grazing of stock on the National Forests. Apparently there is a strong reason for some type of action in the way of separating tourists and stock, or at least fencing out sheep and cattle from the camp grounds. The sentiment is largely against sheep-grazing, although other types of stock were mentioned, in one case by a rancher himself. This sentiment is contrary to the multiple-use policy of the Forest Service and indicates the need for an educational campaign along this line. With the constant pressure being brought by numerous local communities for the creation of National Parks in their vicinity, the need for this education is more real than apparent.

Camps should be more secluded, the bare necessities for convenience furnished, sanitary conditions taken care of, but nothing beyond that done in the way of comfort for the traveling public. The matter of providing camp sites or organized camps where accommodations may be had similar to those in the National Parks does not seem to meet with the approval of most of the people traveling in the National Forests.

That the larger percentage of the questionnaires were returned from people living adjacent to the National Forests indicates that the recreational use of them is largely by the local people. Thus the data as presented represent largely the opinion of the natives of the region. Whether the desires and wishes of these people is common to all the recreational users from other regions is doubtful. The study should be carried out for each of the National Forest Regions, and a summary made for the continental United States.

THE INFLUENCE OF RANGE PLANT COVER ON THE RATE OF ABSORPTION OF SURFACE WATER BY SOILS

By C. KENNETH PEARSE and SAMUEL B. WOOLLEY

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While much attention of late has focused on the construction of engineering works as a means of meeting water deficiencies in the semiarid valleys of the West, comparatively little consideration has been given to the regulatory influence of the soil and rocks of the watersheds, or of the part played by herbaceous range plants in maintaining the efficiency of these natural reservoirs. The study herein reported, which is based upon measurements with inexpensive and portable equipment, reveals that range plants exert a marked influence on the rate water is absorbed by surface soils. Moreover, because plants which are most conducive to water absorption are also of greatest value for grazing purposes, the study clearly suggests that proper range management and adequate watershed protection go hand in hand.

MOST of the water needed for the irrigation of more than 19 million acres in the semiarid West is derived from high mountain watersheds which receive from 30 to 50 inches of precipitation annually. The value of water from this source to the valley communities is largely determined by the uniformity of the streamflow, since high spring floods are frequently followed by low summer flows which result in serious crop losses due to water shortage. Of the many factors which tend to regulate streamflow the most potent is doubtless the absorption of rain and melted snow water by the soil and rock mantle and its subsequent release through yearlong springs and permanent streams. The importance of this regulatory function of the watersheds to western agriculture justifies a thorough study of the absorption of surface water by soils, in order that those persons charged with the management of water-yielding areas and those who are dependent upon mountain water may understand fully the process and the natural variables which influence the supply.

Laboratory studies of the percolation rates of soils as influenced by their chemical and mechanical constitution have been reported by Middleton (7), Lutz (5), and others. Slater and Byers (9) have shown, however, that there is no constant relationship between the percolation rates of field soils in their natural condition and of the same soils when tested in the laboratory. The discrepancy is doubtless due in part to loss of soil structure and in part to the elimination of the direct influence of growing plants in the case of the laboratory soils.

The effectiveness of vegetational cover as a factor in increasing the rate of absorption of water by soils has been pointed out by Lowdermilk (4), Meginnis (6), Forsling (3), and many others, but for the most part studies have been concerned with forest and brush cover. The extent to which absorption might be affected by the presence of range plants has not been reported.

An understanding of the relationship of range plant cover to the absorption of water by surface soil is particularly needed on the National Forest land of the Boise River watershed in southwestern Idaho, where coordination of the uses of several resources presents a serious land management problem. Past exploitation of the grazing resource and the resulting depletion of the plant cover has greatly reduced the productivity of the range and jeopardized the grazing industry. In addition, recent accelerated erosion on the depleted areas has caused ex-

cessive silting of irrigation works and impaired the investments in valley lands and improvements made by the water users in order to utilize fully the streamflow from the watershed.

As a basis for the proper and intelligent utilization of all the resources of this important area, the Intermountain Forest and Range Experiment Station has initiated a comprehensive program of range-erosion research, of which absorption studies, as herein reported, form a part.

Methods

The study was based on the absorption rates of surface water as measured on a number of 1-square-foot plots, 40 of which were barren of vegetation, while 40 supported a single plant specimen each. Of the vegetated plots, 12 bore plants with fibrous root systems, such as *Agropyron spicatum*, *Achillea lanulosa*, *Bromus tectorum*, and *Poa secunda*, while 28 supported plants such as *Balsamorhiza sagittata*, *Lactuca scariola*, and *Lupinus caudatus*, which are typical taprooted species. The plots were located at random over the watershed, but each vegetated plot was paired with an adjacent barren plot not more than 6 feet distant having the same type of soil and the same aspect as the vegetated plot. By pairing the plots in this manner the effects of soil heterogeneity and variations in soil moisture on the absorption rate were eliminated from the study.

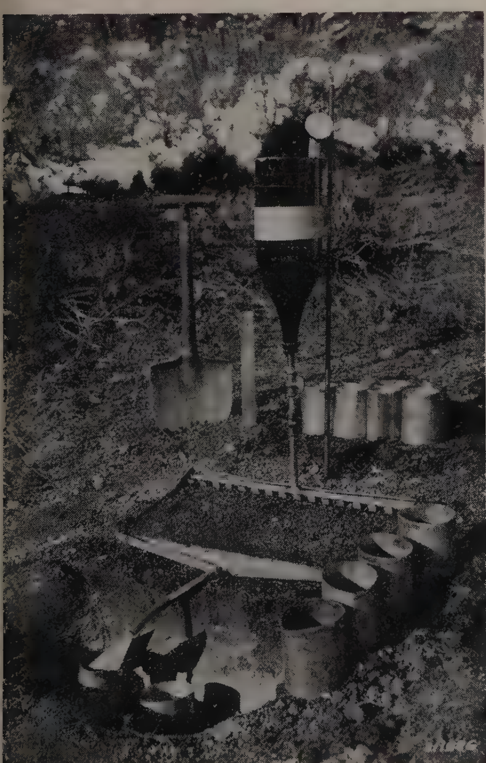

Fig. 1.—The apparatus set up to measure the absorption rate of a barren plot.

To measure the rate of absorption of surface water by the plots, special equipment was used (Fig. 1). By means of this apparatus a thin sheet of water was run over the surface of the soil at a known rate. By subtracting the rate of run-off from the rate of application, the rate of absorption of water by the soil was determined. It was found that the soils absorbed water at a nearly constant rate after the first 2 or 3 minutes of each test, and it is on this constant rate that the analysis is based. Upon the completion of each test, which was continued for 10 to 12 minutes, a cross section was cut through the plot and the exposed soil profile was drawn to show the depth of penetration of the absorbed water.

Results

The study indicates a close relationship between the rate of absorption of water by the soil and the presence and character of the plant cover. In general, as shown in Table 1, plots bearing a single plant absorbed water .0275 inch per minute faster than did the adjacent barren plots, an increase of 71.2 per cent due primarily to the presence of a plant. Soil differences had no part in bringing about this increase, since analyses of sam-

ples showed that the soils of the paired plots are almost identical (Table 2).

Plots supporting fibrous-rooted plants absorbed water .0453 inch per minute faster than did corresponding barren plots, an increase of 127 per cent due to the presence of fibrous-rooted species. In comparison, plots supporting taprooted species absorbed water .0206 inch per minute faster than did adjacent plots devoid of vegetation, an increase of only 51.5 per cent due to taprooted species. These figures indicate that although the presence of any kind of herbaceous plant favors the absorption of surface water by soils, the fibrous-rooted species are about two and one-half times as effective in increasing absorption as are the taprooted species.

An explanation of the effectiveness of plants in increasing the rate of absorption was afforded by an examination of soil profiles after each run. These showed that on the vegetated plots the water had followed the root channels to a large extent, resulting in an increase in penetration in the immediate vicinity of the roots. The numerous fine roots of the fibrous-rooted species, as compared to the fewer coarse roots of the taprooted class, resulted in a greatly increased rate of absorption when fibrous-rooted plants were present.

Significance

The ability of soils to absorb surface water is doubtless affected by many factors in addition to the presence or absence of plant life as dealt with in this paper. Among the most important of these factors are such soil characteristics as texture and the content of moisture and organic matter. In this study, although soil differences were taken into account by the use of paired plots, soil heterogeneity was not controlled since the plots were located at random over the watershed. Because the study was made on a variety of soil types, the results can be applied to the watershed as a whole and are of general significance from the standpoint of the administration of water-yielding areas.

This study has shown that by maintaining a satisfactory stand of fibrous-rooted plants absorption of surface waters by the soil can be greatly increased. This is desirable from the water user's standpoint for several reasons: The replenishing of the water table which supplies the flow for yearlong springs is accomplished only by the percolation of surface water through the soil. The water which is thus added to the ground water supply is later delivered to the streams in a slow, uniform flow, in marked contrast to the flash-flow of surface run-off, and is highly desirable for irrigation and industrial use. Finally, since it is only surface water which causes erosion, rapid absorption of precipitation by the soil will do much to prevent this process, which strips the watershed of its fertility and is responsible for the silting of reservoirs and canals.

Table 1

THE ABSORPTION RATES OF FIELD SOILS AS INFLUENCED BY THE PRESENCE OF PLANTS

Kind of plant cover	Mean rates of absorption (inches per minute): On 40 barren plots	On 40 vegetated plots	Increase due to plants (per cent)	Probability value[1]
All species	.0386	.0661	71.2	.01
Fibrous-rooted species	.0356	.0809	127.0	.01
Taprooted species	.0400	.0606	51.5	.01

[1]Based on the "T" test as described by Fisher (2), these values indicate odds of 99 to 1 that the differences in absorption rates of the barren and vegetated plots are real.

In the interest of the range livestock producer it is desirable to maintain the best possible stand of palatable forage species on every range unit. Since almost all of the palatable forage plants are fibrous-rooted species, it appears that grazing, irrigation, and community interests would profit through the development and maintenance of good stands of fibrous-rooted, highly palatable range species on range-watershed areas.

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Table 2

COMPARISON OF THE SOILS OF THE PAIRED PLOTS

Determinations	Barren plots (40 samples)	Vegetated plots (40 samples)
Mechanical analysis[1]	Per cent	Per cent
Coarse gravel, over 5 mm	7.3	7.5
Gravel, 2-5 mm	24.6	24.0
Sand	48.9	49.6
Silt	11.0	11.0
Clay	8.2	7.9
Total	100.0	100.0
Total colloids[1]	11.6	11.8
Organic matter[2]	1.619	1.679
Total nitrogen	.119	.118

[1]By the method of Bouyoucos (1)
[2]By the method of Schollenberger (8)

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FACULTY RESPONSIBILITY IN FORESTRY EDUCATION

By R. H. WESTVELD

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FORESTRY education has been discussed and analyzed since its advent in this country, at first rather superficially, but more recently in a thorough-going and fundamental manner. In some instances teaching methods and quality of instruction have been referred to, but it is doubtful whether this phase has received the attention that it should. That the facilities and provisions for instruction play an important part in the quality of the product (the forestry graduate) produced by a school is demonstrated in Chapman's report.[1] One does not have to be in entire agreement with the analyses in the report (the author is not) to reach this conclusion. Six schools which were not accepted by the Society had faculty provisions that were rated 77, 38, 40, 50, 51, and 40 per cent, and their records on recent civil service examinations rank 71, 70, 70, 60, 73, and 57 per cent. On the other hand, the undergraduate school faculties that rated 98, 98, and 96 per cent (the school with the highest rating, 99 per cent, is a graduate school) were rated 93, 85, and 89 per cent on recent examinations. The correlation is convincing. Carried still farther, the analysis will show that these nine schools rate in the following order on the basis of the final grades of school and alumni: 55, 52, 52, 53, 49, 56, 93, 97, and 95 per cent. Again the correlation is close. Although there are other factors than the caliber of the faculty personnel and the facilities they have for instruction that affect forestry education, it is one of the most important. In the final analysis this factor indirectly includes financial support (a very important item), since the provisions for instruction are influenced by the budget.

Although the make-up of the forestry curriculum has been carefully analyzed in the past, a comment may not be out of order. Some forestry educators are alarmed over the increasing volume of forestry subject-matter, and are convinced that this additional material cannot be included unless a fifth year is added to the course of study. Why not add the fifth year solely for the inclusion of more economics, sociology, political science, psychology, and other cultural subjects? The required credit hours of forestry ranges from 23 to 55 in the different schools. Study of Chapman's report does not reveal that the alumni from the schools with the maximum hours of forestry have the best record. One school with a minimum of forestry has a high alumni rating; likewise one school with a large proportion of forestry (over 45 credit hours) has a high alumni rating; while three schools with more than 45 credits of required forestry have alumni ratings slightly better than average. In the first two schools the faculties are both rated 98 per cent by Chapman; in the three latter schools, the faculties are slightly better than average. Which is more important within the limits of existing curricula, the curriculum, or the character of instruction?

The discussion which follows is based on eight years of teaching experience. It is not meant to be complete in any way. It covers only a few pertinent points that have come to the author's attention, and

[1]Chapman, H. H. Professional forestry schools report. Soc. Am. For., Washington, D. C. 1935.

it is hoped that these comments will stimulate interest in improved teaching in forestry. The points discussed below are by no means confined to teachers of forestry. They apply equally to any college instructor.

Poor Preparation.—Some teachers are always poorly prepared to meet their classes. Reasons for this are too numerous to mention. If the teaching load is too heavy, inadequate preparation is excusable, otherwise not. Teaching should be the first duty of an instructor; research, administrative duties, etc., should receive secondary consideration. Poor preparation is reflected in lack of knowledge of current developments, poor organization of subject-matter, lack of self-reliance and confidence, lack of conviction in speech, and, in certain types of individuals, bluffing. Some of these lead the student to believe that the instructor is not interested in his subject.

Poor Organization of Subject Matter.—Regardless of how comprehensive and up-to-date an instructor's subject-matter may be, if it is not presented in logical sequence it misses its goal. Ample time for preparation is in large part the solution. Students readily recognize both poor preparation and poor organization, because they have contact with enough instructors free of these deficiencies to use as examples. Capable and conscientious students resent these two deficiencies, and do not hold in esteem the bluffer. Good organization of subject-matter, plus forceful convincing speech, results in excellent presentation which will give the student no alibi for poor work.

Expecting too Much or too Little of the Student.—Students are supposedly in college to assimilate facts and principles which will develop their powers of observation and analysis, improve their judgment, develop their initiative, and develop a sense of open-mindedness. Giving the right amount of work in the proper manner is something that demands rare judgment. The student should have enough work to keep him busy, but the fact that he is carrying three or four other courses should not be overlooked. Too much work can discourage a student in his effort conscientiously to assimilate the material. On the other hand, the instructor should not do more than his share of the work. The teacher who hands out information on a silver platter fails to develop initiative and a sense of responsibility in the student. Instruction should be a 50-50 proposition.

Sympathy toward Students.—This point also requires a fine sense of proportion. Too much sympathy for a student's problems is as degrading as too little. The building of character is as important a part of education as is technical instruction in a particular subject. Analyzing a student's problems and difficulties fairly and squarely should develop the proper outlook on life, whereas brusqueness may lead to discouragement, and too much benevolence weakens character.

Promptness.—Promptness in the accomplishment of work should be a requirement of both student and instructor. Capacity for work is measured at least in part by ability to complete the job on time. Excellent training in this can be provided in college. The instructor should demand that the student present reports at specific dates, and that he be on time for field trips. Penalties can be imposed for failure to comply. Unfortunately there is no practicable method of penalizing instructors for not being prompt. Examinations accomplish little if they are not returned to the student within a few days after they are written. Promptness on the part of the teacher in other matters is equally important.

Follow-up on Examinations and Reports.—Examinations and reports can be a valuable part of the instruction if used properly. A thorough discussion of an examination as soon after it is given as possible is invaluable in many courses.

Not only does it clear up questionable points, but it has a desirable psychological effect on the student.

Students often look upon reports as a routine, unnecessary evil. They are, when handled in a routine, perfunctory manner. At the 1933 meeting of the Society, members of the Forest Service levelled severe but just criticism at the caliber of reports presented by the younger members of their personnel. In an effort to overcome this deficiency, the author tried out a suggestion made by Prof. P. A. Herbert. The plan was to study the reports critically for content, organization, spelling, English, conclusions (completeness and logic), and bibliography (only in the type of reports in which this was needed); to make ample comments on the margins of the pages; and to give a grade of F on reports which did not meet a certain standard (even though they were good enough for a passing grade), but with the understanding that this grade could be replaced by a higher one if the report or such parts as necessary were rewritten in line with the instructor's suggestions. This procedure was followed with a group of students through four consecutive courses, beginning late in the sophomore year and ending in the junior year. In the first course approximately 50 per cent of the reports had to be rewritten. In subsequent courses there was a gradual improvement, until in the fourth course only one report out of 20 had to be rewritten. The results were encouraging in spite of the fact that one student in the fourth course persisted in spelling sapling "sappling," after a year of correction, and misspelled other simple common words.

The procedure just outlined is time-consuming, but accomplishes something worth while. If education is to develop something that is more than a human machine, the instructor must devote this additional time to it. Incidentally, this is justification for lighter teaching loads.

Loose Usage of Technical Terms. — Loose usage of technical terms is fairly common among practicing foresters, and is noticeable in forestry instructors. Improvement in this matter cannot be accomplished by the instructor's efforts only. Editors of forestry periodicals will have to be more insistent on correct usage of technical terms, and foresters individually will have to inventory their vocabulary in an effort to speak and write correctly.

Common names of trees are used without discretion, and technical names are nearly always forgotten. In one issue of the JOURNAL OF FORESTRY the following errors and broad interpretations were used: lowland fir for lowland white fir; arborvitae for either western red cedar or Port Orford cedar (the author is not sure); fir for balsam fir; maple for sugar maple or red maple, or possibly both. Technical names did not appear in any instance. In contrast, forest entomologists and forest pathologists in general are very careful in their terminology.

Possibly the faulty usage of common and technical names can be traced to the instructors of silviculture and utilization. Unless instructors in courses other than dendrology demand proper usage of tree names in both spoken and written form, students are likely to forget their dendrology, or to use its terminology as their faulty memory sees fit.

The term tolerance as applied to trees is badly abused, in spite of our realization that it involves more than a consideration of light. Probably the student acquired a proper understanding of the meaning of this term in his silvics course, but in later assigned readings or in conversation he finds it used in a more restricted sense, and therefore decides that the instructor was too scientific or wrong.

The term thinning is used very freely. It is true that any type of cutting, in a sense, acts as a thinning; but foresters should use it to mean a specific type of cutting. Frequently the term thinning

is used in reference to selection or shelterwood cutting.

Other technical terms are probably used as loosely as the foregoing in other fields of forestry which the author has not followed so closely.

Character of Examinations.—The discussion or essay type and the objective type of examination are the usual forms of written examinations. Each has its advantages, and few courses are complete unless some of each is used. The objective examination demands clear, careful thinking, by both instructor and student. The fact that it is definite provides an opportunity to examine the student thoroughly on facts, principles, and relationships. It serves as a show-down on the bluffer type of student. True and false statements, problems, completion of statements, and relations between cause and effect are useful on such examinations. The instructor must plan to give much time and thought to the preparation of objective examinations, otherwise they will not accomplish their purpose.

The discussion type of examination is valuable in developing orderly, concise thinking and presentation. It demands also a weighing of the relative importance of facts and relations.

Field Work.—Field work is an important phase of many forestry courses. The nature of this work depends so much on the subject that generalizations are of little value. However, careful planning and organization of the field work is as important as careful organization of other subject-matter. Every field project should have a definite objective, and should be carefully tied in with the lectures and discussions. In a silviculture course dealing with methods of cutting, it is possible to develop clear, logical thinking by having the students in the class criticise their fellow-students' selection of trees for cutting and ask for reasons for the selection of trees or groups of trees. This procedure develops an alertness which is valuable in any kind of thinking.

Student Rating of Faculty.—The instructor who is interested in improving himself as a teacher can find out where to start by asking the students to rate him on certain qualities at the end of each course. Some instructors may question the value or accuracy of such ratings, but the author, after seeing the results of four years on six instructors at Michigan State College, is convinced that the data gave a fairly true picture of the capabilities of the different men. When certain strong or weak points show up consistently in the ratings by several different groups of students, it is significant. Some personal feeling will enter into the ratings, but in general the students are fair in their analysis. If a single student rates an instructor 0 on a particular quality when most of the ratings range between 7 and 9.5 (on the basis of 10), it is obvious that personal feelings have played a part.

The forestry faculty at Michigan State College used a rating sheet which considered the following qualities: interest in subject; sympathetic attitude toward students; fairness in grading; liberal and progressive attitude; presentation of subject-matter; sense of proportion and humor; self-reliance and confidence; personal peculiarities; personal appearance; and stimulating intellectual curiosity. Varying degrees of each quality were expressed on a graduated scale upon which the student made a check at the point which, in his opinion, most nearly described the instructor. The instructor who is conscientiously giving his best effort to the job and who wishes to make progress will welcome student ratings.

EFFECT OF FIRE IN PREPARATION OF SEEDBED FOR LONGLEAF PINE SEEDLINGS

By H. H. CHAPMAN

Yale School of Forestry

OBSERVATION of the behavior of longleaf pine seeds during the period of germination, which occurs within one month of the fall of the seed in October, indicates the importance of removal by fire of any vegetative ground cover which can act as a mechanical obstruction to the contact of the seed with mineral soil.

The large size of the seed, to which the wing is firmly attached, prevents it from penetrating or sifting through such obstructions. On germination, the radicle soon dries up and the seedling fails of establishment.

Permanent plots of 1/100 acre at Urania, La., the first of which were established in 1917, have furnished a record of initial establishment and of later survival covering heavy seed crops in the years 1919, 1920, 1927, 1928, and 1935. The first two of the three periodic seed crops were, as noted, split into two successive years. The 1935 crop was concentrated in one year.

Exclusion of fire was the policy at Urania from 1915 until 1928, when tentative experiments were begun in controlled burning. The fires which occurred during this period (as in 1924) were incendiary, except for controlled fire in certain areas after 1928.

Hogs were excluded by fencing.

In Table 1 the effect of different types of ground cover is averaged irrespective of the disturbing influences of fire and grazing. In Table 2 the effect of the period elapsed since the last fire is averaged irrespective of the effect of different types of ground cover.

Further analysis of these results on the ground indicate the following facts.

1. Bare plowed soil is the most favorable germinating bed for longleaf pine seedlings. Unfortunately no burn more recent than two years old was present in open land favorable for stocking, though on a protective winter burn in 1935, in a fully stocked pole stand which had been previously protected from fire since 1915, 24,250 seedlings were found to the acre. None of the pole timber was killed by this fire.

2. Where broom sedge is replaced by carpet grass due to heavy grazing, the site ranks next in favor for seedlings. Continued heavy grazing will cause the loss of about half of these seedlings by being eaten. This does not occur after the first year.

3. Sites not occupied by broom sedge, with soil partly exposed, produce a large percentage of survival. Such sites resemble broom sedge areas which have been burned the winter before the seed fall.

4. Hardwood leaf litter is very favorable for germination. This condition seems to continue for many years even in the absence of fire. The seedlings find their way to the soil through or between the leaves, whose rapid decay seldom establishes a mat of litter thick enough to exclude germination. In our records, however, not a single longleaf seedling has ever survived under the shade of either hardwoods, pine, or brush of any kind, and this record covers two major seed crops and a period of 20 years.

5. Pine straw is an unfavorable site. Two or three years' accumulation of needles may exclude seedlings altogether,

the few which come in being found only on spots of bare soil. This fact was established in Alabama in 1908.

6. The most effective cover in total exclusion of seedlings is broom sedge which has remained unburned long enough to form a mat of dry dead grass. This mat does not decay, but remains free from contact with the soil, and may be 6 inches thick. Where grazed heavily enough to trample or eat down the grass, or finally to replace it with carpet grass, the effect is mitigated or removed altogether. In Table 2 the contrast between grazed and ungrazed areas following a fire in 1933 is strikingly shown. Cattle grazing, except for the damage during the first season after establishment, is of definite benefit to longleaf pine reproduction.

The effect of fire exclusion is thus purely a mechanical one, dependent on the rapidity with which the ground becomes covered with an impervious blanket of dead vegetal remains. Evidence in ungrazed areas of broom sedge indicates that three years is sufficient to exclude practically all reproduction at Urania. Wire grass is worse than broom sedge.

The destruction caused by fires occurring in the first spring after germination is clearly shown. The only remarkable thing is the survival of a few seedlings. This occurs only where the grass is thin and the bud escapes injury.

Experiments with fire on longleaf seedlings from 1 to 3 feet high showed the remarkable protective role of the foliage in resisting heat. Tissue paper placed around the buds of these seedlings was not even scorched, although hot flame seared the needles to within 3 inches of the bud. Where the flame reached the bud, death ensued. The negligible mortality of seedlings after the first year, following winter fires, is due to this fire resistance and protective role of the foliage and the position of the bud next to the ground. A winter controlled fire killed less than 1 per cent of seedlings from 1 to 3 feet high; but an incendiary fire in March, on a hot windy day in

TABLE 1

EFFECT OF CHARACTER OF GROUND COVER ON ESTABLISHMENT OF LONGLEAF PINE SEEDLINGS OF THE CROP OF 1935. (10-MILACRE PLOTS)

Character of ground cover	Area, acres	April, 1936 seedlings, number	Average per acre
Plowed soil	.004	603	158,900
Carpet grass	.13	7,391	56,870
Soil partly bare	.02	914	45,700
Hardwood leaves	.115	4,455	38,740
Pine needles	.18	2,427	13,480
Sedge grass	.466	2,920	6,270

TABLE 2

EFFECT OF PERIOD SINCE LAST FIRE ON ESTABLISHMENT OF LONGLEAF PINE SEEDLINGS OF THE CROP OF 1935, IGNORING EFFECT OF ALL OTHER FACTORS

Year	Period elapsed, years	Area, acres	April, 1936 seedlings, number	Average per acre	Forest cover
1924	12	.21	26	120	Open
1928	8	.11	205	1,850	Open
1931	5	.033	1	33	Open, ungrazed
1933	3	.096	4,834	50,360	Open, grazed
1933	3	.033	28	848	Open, ungrazed
1934	2	.08	5,198	64,730	Open, grazed
1935	1	.06	1,456	24,250	Completely shaded
1936	0	.275	48	170	Burned in spring after germination.

the afternoon, killed from 35 to 50 per cent of these seedling classes, but less than 5 per cent of those whose height growth had not started.

The role of controlled winter fire during the first 7 to 8 years of the seedling's life is to kill back all competing vegetation, including pines, hardwoods, (this includes blackjack oak), and brush, whose survival will exclude longleaf; to control the brown spot disease for a period of at least two years; and to prevent disastrous summer fires, which may kill (and at Urania have killed) 90 per cent of seedlings before height growth starts.

Longleaf pine forests throughout their range invariably grow in pure stands, for the reason that the seedling cannot thrive in competition with other tree species, brush, or even grass, in the absence of repeated fires preceding and during its period of establishment. It is the only species which can survive fires burning at 2- to 3-year intervals. Fire damages longleaf pine when it burns annually, or at the wrong season, or even at the wrong time of day or condition of the atmosphere. A "controlled" fire at Urania set back the growth of 3-year old seedlings 2 years, through the error of burning in the heat of the day with a wind. Longleaf pine sites are those whose soil produces inflammable grass and brush, and on which a natural occurrence of fire is to be expected at 2- to 3-year intervals unless fire is deliberately set every year. This condition does not hold on loblolly, shortleaf, and hardwood sites, and natural exclusion of longleaf resulted.

Substitution of other species on longleaf pine sites does not alter the soil nor the natural fire risk. In my opinion, reinforced by observation and experience, fire exclusion in pole stands of longleaf pine exposes the stand to an increasing hazard which may become uncontrollable and result in total destruction, as it did four times at Urania, whereas winter controlled fires in these pole stands has removed this danger and rendered the stands safe from fire at any season.

A THINNING EXPERIMENT APPLIED TO TIMBER STAND IMPROVEMENT

By G. A. PEARSON

Southwestern Forest and Range Experiment Station[1]

The following paper gives the results of the oldest thinning experiment in the Southwest, established 10 years ago. When the C.C.C. and other relief programs made man power available for timber cultural operations on a large scale, thinning plots established by the experiment station furnished the only background for development of methods. Applied to the Southwest, timber stand improvement is a much more appropriate term than thinning, because thinning is only part, and often a small part, of the operation. Yet the old thinning plots are yielding much information applicable to the present stand improvement practice. Lines along which further studies should be made are pointed out. "Crop tree" thinning, touched on in this paper and widely used in C.C.C. operations in the Southwest, is discussed more fully in the next article, by E. M. Hornibrook.

THE usual object of thinnings is to increase the growth rate of a desired class of forest product. Thinnings do not always increase total volume production, but they may be expected to increase the yield of a given class of material, such as saw timber. Attention is focused on individual trees more than on the stand as a whole. Assuming that size is a requisite for merchantability, the object of thinning is to maintain rapid growth in a limited number of trees per acre, even though their aggregate volume growth may be less than that of a larger number of small trees. The practical effect is to shorten the rotation or the cutting cycle.

Regulation of competition is a basic concept in thinning practice. Thinning presupposes the presence of more trees on a given area than can grow to maturity, or the required size. In densely stocked stands, thinning comes about naturally, by suppression of the weaker trees, though often at a great sacrifice to the survivors as well as the vanquished. Moreover, under the law of survival of the fittest, the trees that are biologically most fit are too often of low utilization value.

Within limits, competition is beneficial. Laymen and even foresters sometimes advance the idea that the need for thinning can be forestalled by timely measures to prevent dense stocking. This has been a favorite argument in defense of grazing damage. If such measures could be adequately controlled, they would have merit; but, in practice, control is seldom possible and the result is too likely to approach denudation. Dense stocking in youth is necessary to develop timber form, aid natural pruning, and give adequate play to natural selection.

By timber form is meant straight boles, free of thick limbs and extreme taper. Unless taper is considered, rapid diameter growth at breast height may be very misleading. As an example, by no means unusual, measurements of a 52-year-old open-grown pine on the Prescott are cited. Diameters inside bark were: stump 15.3 inches, at 4½ feet 14.4 inches, at 16 feet 9.5 inches. In other words, this 15-inch tree (d.o.b.) would barely scale one 16-foot log.

[1]The Southwestern Forest and Range Experiment Station is maintained in cooperation with the University of Arizona.

As a rule, the lower portion of the bole in open-grown trees such as the above fairly bristles with dead limbs 2 or 3 inches thick. Natural pruning in this region is somewhat of a misnomer, but in dense stands the branches of most trees remain small and eventually break off. Artificial pruning in such stands is relatively cheap.

That natural selection operates in the development of tree stands may be a novel idea, but nature furnishes evidence that this is a factor to be reckoned with. Desirable types have straighter boles and finer limbs than the average tree, even in relatively open situations. Unless there are large numbers of young trees from which to choose, selection of desirable types in thinning will be difficult or impossible.

Character of Second-Growth Pine Stands in the Southwest

To understand cultural practices employed in the Southwest it is necessary to visualize the stands as they occur. Almost without exception, the young pine stands suitable for thinning are of a 40- to 50-year age class. It is seldom, however, that they are strictly even-aged. Usually there is a more or less prominent representation of individuals from 5 to 10 years older than the main stand, and these older trees are nearly all in the dominant class. Extreme limbiness, incipient heart rot, crooked or forked boles eliminate many of them as potential saw-timber trees. Stocking is seldom of uniform density over areas of more than one-tenth of an acre. Groups that are essentially of the same age vary from wide spacing with large, limby trees to spacing so close that the stems are whip-like. It is difficult to obtain, even in small plots, the uniformity desired for experimental purposes. Mistletoe and porcupine damage are additional factors that must be taken into account.

Early Thinning Practice

The first attempts at thinning quickly demonstrated the futility of trying to adhere strictly to any of the standard European systems. In general, thinning has been from below, modified by the need for removing dominants that are undesirable because of poor form, excessive limbiness, porcupine damage, or mistletoe infection. No attempt was made to adhere to an arbitrary spacing, but rather each tree reserved was given space in proportion to its immediate and near future demands. Generally, the crowns were freed on at least three sides. Ten years was the time tentatively set for the next thinning. Spacing sufficiently wide to sustain accelerated growth for a longer period was not considered advisable because of the danger of opening the crown canopy too much.

Pruning

On some plots, thinning has been followed by pruning of dead or dying limbs to a height of 17 feet, but live limbs were not removed to any great extent in order to attain this height. Pruning makes it possible to leave dominants which otherwise would not meet saw-timber standards.

Initiation of the Thinning Experiment

The oldest experimental thinning plots in Region 3 were established on the Prescott in 1925. A plot of 4.2 acres was thinned and an adjoining one of 0.8 acres was left as a control. They were remeasured in 1930, and again in 1935. A second control plot of 0.24 acres was established in 1930.

The stand was second-growth ponderosa pine of pure composition save for a few junipers (*J. pachyphloea*) and oaks (*Q. arizonica*). Logging dates back 60 years or more, but, following the usual practice in early operations, the first

cutting evidently left young and defective old trees which seeded up the area and were later removed. Occasional mature trees still remain on nearby ridges. Stump counts in 1925 determined the average age of the young stand to be 41 years, a few individuals being as much as 5 years above or below this figure. There were also a few 60-year-old trees, most of which were cut on the thinned plot.

Physiographic features are typical of the pine type in the Prescott region. The soil is derived from granite, very granular and in places shallow. Old gullies, now mostly sealed with pine litter, bear evidence of severe erosion before the trees became large enough to establish a cover. Now, even after thinning, a uniform mat of pine needles covers the soil and holds it in place. The altitude of the town of Prescott is 5,400 feet. The plots, about 4 miles south, lie about 400 feet higher. Weather Bureau records at Prescott give an average annual precipitation of 18.53 inches; the plots may receive 1 or 2 inches more. Compared with stations in the pine type on the Colorado Plateau, Prescott, in the lower edge of the type, receives 4 inches less precipitation and has a mean annual temperature some 7° F. higher than the average.

The method of thinning was essentially the same that has been outlined. More attention was given to the removal of large undesirable trees than suppressed and intermediate ones, on the theory that the latter type, unless very numerous, interfere but little with larger trees. The marking was done by the writer and Assistant Supervisor John C. McNelty of the Prescott. Cutting was handled by the Prescott as an administrative sale, which removed 11.25 cords of wood and 4,680 lineal feet of poles (top diameter 4 inches). After the thinning, there were on plot A 267 trees per acre, mainly between 4 and 11 inches d.b.h.; a record before cutting is not available. The unthinned control plot, B, contains 772 trees per acre. The second control plot, D, is stocked at the rate of 675 trees per acre.

Comparison of Growth on Thinned and Unthinned Plots

Basal Area.—Table 1 shows that plot A, after thinning, had the lowest initial basal area but has made the highest increment. The presence of more large trees (above 11 inches d.b.h.) on the thinned plot is probably a contributing factor to its greater increment. These trees are all distinctly dominant, and despite their larger size are increasing in diameter as rapidly as the smaller trees. The unthinned plots appear to have stagnated. The second control plot, D, was selected 5 years after the first plots were established, because it was thought that the first control plot possibly was on a poorer site than the thinned plot. Control plot D is on a level bench and bears all indications of good site quality; but during the one period when all three plots are comparable, the lowest increment was re-

Table 1

INCREMENT IN BASAL AREA ON THINNED AND UNTHINNED PLOTS, BY PERIODS

Plot and treatment	Year established	Area of plot	Basal area per acre: Total, first measurement	Net increment: 1925 to 1930	Net increment: 1930 to 1935	Net increment: 1925 to 1935
		Acres	*Sq. ft.*	*Sq. ft.*	*Sq. ft.*	*Sq. ft.*
A. Thinned	1925	4.2	82.97	14.55	12.06	26.61
B. Unthinned	1925	0.8	117.28	13.64	5.84	19.48
D. Unthinned	1930	0.24	153.26	......	3.63	......

corded on this plot, despite the fact that it had the greatest initial basal area. Theoretically, a large number of stems should produce as great a total increment as a smaller number, assuming that both areas are fully stocked. But a certain minimum of water and nutrients is used in merely keeping a tree alive—supplying the inevitable transpiration, putting forth new leaves, stems, flowers, and cones. If there is no margin above this minimum the trunk can make no growth at all. As has been determined for herbaceous plants, unfavorable growing conditions increase the water requirement per unit of dry matter produced. The performance of such a stand is comparable to a business in which overhead eats up the profits.

Diameter Growth.—It is evident from Table 2 that diameter growth is much greater on the thinned plot, A, than on the unthinned control, B. Besides producing a smaller volume of new wood, the increment is distributed over a larger number of stems on the unthinned than on the thinned plot. This difference in number of trees is mainly in diameters below 8 inches.

On both thinned and unthinned plots, there is a pronounced increase in rate of diameter growth as the trees pass the 5-inch class. This may be attributed to the fact that the upper diameter classes contain a larger proportion of dominant trees. The larger trees usually occur in the small openings which are common even in the densest stands; they are also taller than the trees of smaller diameter, as may be seen in Table 2. In short, the larger trees hold a dominating position both in the soil and in the crown canopy, and this enables them to grow at the expense of the smaller ones. As time goes on, many of the smaller trees will continue to decline while the larger ones increase their lead until they come into competition with one another. According to Table 2, the trees above 8 inches d.b.h. are making fair growth without thinning, and this fact may well raise the question of whether thinning is

TABLE 2

COMPARISON OF THINNED PLOT A AND UNTHINNED PLOT B WITH REFERENCE TO NUMBER OF TREES PER ACRE, AVERAGE HEIGHT, AND AVERAGE DIAMETER GROWTH IN 10 YEARS

D.b.h. class	Trees per acre in 1935		Average height in 1935		Average growth in d.b.h. 1925 to 1935	
	A	B	A	B	A	B
	Number	*Number*	*Feet*	*Feet*	*Inches*	*Inches*
1		2.5	——	——	——	0.1
2	1.2	61.2	——	27.0	0.6	0.2
3	8.6	145.0	21.0	24.4	0.6	0.2
4	19.5	132.5	26.4	27.7	0.7	0.3
5	37.8	126.2	33.6	31.7	0.8	0.4
6	51.4	95.0	35.6	35.3	1.4	0.5
7	40.0	67.5	38.0	35.8	1.3	0.7
8	38.3	42.5	41.0	38.5	1.1	0.7
9	26.2	26.2	43.4	41.9	1.1	0.8
10	15.9	12.5	44.1	44.4	1.3	0.9
11	14.3	6.2	47.3	46.3	1.2	0.9
12	6.7	——	52.0	——	1.4	——
13	2.6	——	45.0	——	1.3	——
14	1.4	——	51.0	——	1.2	——
15	——	1.2	——	——	——	0.4
16	——	——	——	——	——	——
17	0.2	——	58.0	——	1.2	——
18	——	——	——	——	——	——
19	——	——	——	——	——	——
20	0.2	——	——	——	1.1	——

really necessary in ponderosa pine stands as they commonly occur in the Southwest.

Essentially the same relationships that have been expressed are found by classifying the crowns as to size and condition. By size of crown is meant its volume in relation to diameter and height of tree; and the two factors, size and condition, provide a rough measure of leaf area. The classification was made by observation, which is admittedly a crude method, but nevertheless a consistent relation was obtained. The comparison based on 1925 and 1930 measurements on the thinned plot is given in Table 3.

Application to Timber Stand Improvement

Timber stand improvement methods in the Southwestern Region are an outgrowth of thinning experiments. During 1933, the first year in which extensive stand improvement was practiced, the methods were essentially those of the earlier thinnings. Subsequent developments have been mainly in the way of substituting release of selected crop trees for a general thinning designed to stimulate all trees left in the stand. Pruning is confined to crop trees. An important advantage of the method is that it permits adequate release of crop trees without opening up the entire canopy in such degree as would result from a liberal release of all reserved trees. Figures 1 and 2 illustrate the two methods. Standard practice on the National Forests is to select crop trees at the rate of 80 per acre, on the basis of fully stocked stands, as a general average for large areas. Usually the number falls below 80 per acre, because openings occur in the stands.

In 1935, crop trees were selected on all three of the Prescott plots according to Region 3 standards. The most thrifty dominants were designated, with due regard for form and spacing. The average number per acre proved to be only 62, which is somewhat below the standard. Because the degree of thinning around crop trees on the thinned plots was less heavy than usual practice in stand improvement, the rate of growth is probably somewhat below what may be expected on similar sites under the present crop-tree method. On the unthinned plots, the growing space of crop trees is naturally still more restricted, although no difficulty was experienced in finding trees of suitable crown development.

Growth of Crop Trees.—A comparison of diameter growth in Tables 2 and 4 points to a slightly higher rate for crop trees than for the general run of trees in corresponding diameter classes. On the thinned plot, the margin in favor of crop trees probably is not sufficient to enable them to hold a distinct advantage over their competitors of approximately

Table 3

DIAMETER GROWTH IN RELATION TO SIZE AND CONDITION OF CROWN, 1925 TO 1930

Relative size of crown	Condition of crown	Trees in class	Average diameter growth	Trees growing over 0.5 inch
		Number	*Inches*	*Per cent*
Large	Good	165	0.83	88
Average	Good	619	0.62	60
Small	Good	94	0.39	13
Large	Medium	6	0.75	83
Average	Medium	83	0.48	30
Small	Medium	86	0.36	7
Average	Poor	21	0.31	5
Small	Poor	46	0.26	6

the same diameter and height, because here all trees have received some benefit from thinning. To maintain the dominance of crop trees will require additional cutting. If crop trees on the unthinned plot were released sufficiently to bring their growth rate up to that of the crop trees on the thinned plot, they would have a distinct advantage over their more crowded neighbors. This is the objective in crop-tree thinning—not only to increase the growth rate of crop trees but also to retard the growth of noncrop trees and thus hold them in subjection.

Both crop trees and others have fallen off in diameter growth during the second 5-year period. Since this is true of the unthinned plots as well as the thinned, the decline may be due to climatic influences. During the first period the average annual precipitation at Prescott was 22.77 inches, as compared with 21.09 inches the second; but both are well above the 65-year average of 18.53 inches. That the trend of diameter growth in the thinned plot will be downward must be expected unless additional thinnings are made. By frequent thinnings, it should be possible to maintain or increase the present diameter growth for several decades. In a Danish plantation of red spruce thinned at intervals of 3 to 5 years over a period of 22 years, current diameter growth has declined under "very light" thinning but has risen under "normal heavy" thinning. A time must come, however, when crop trees will compete with one another, and then diameter growth, if not volume increment per tree, will decline. How long diameter growth can be maintained at a specified rate depends upon various circumstances. In Tables 2 and 4 there is no indication of decline up to 12 inches, beyond which point the data are inadequate. On sample plots after logging, thrifty black jacks 20 inches d.b.h. grow in diameter as rapidly as 12-inch trees. In about 15 years both decline, but it is reasonable to assume that a second cutting would bring about a renewed acceleration. Biologically, there is no reason why, with continual removal of competing vegetation, pine should not maintain a uniform width of rings until it approaches

Courtesy U. S. Forest Service

Fig. 1.—A thinning plot on which all the reserved trees have been released and pruned.

Courtesy U. S. Forest Service

Fig. 2.—A stand improvement plot on which only crop trees have been released and pruned. The tall, pruned tree in the middle foreground is a crop tree.

senility. In practical management, however, it will encounter competition not only from other large trees but from sapling thickets and herbaceous vegetation. Obviously, a uniform rate of diameter growth over a period of years means a rising rate of volume increment per tree. This is possible only if expansion of leaf area and root area keeps pace with increase of wood volume. A stage may eventually be reached where sheer size becomes a limiting factor, but limitations imposed by competition or declining physical vigor come into action much earlier.

Conclusions and Future Objectives

Research objectives in thinning experiments are many and varied. That thinning increases diameter growth in the trees remaining in the stand has been demonstrated both experimentally and in extensive silvicultural practice; previous findings in this respect are corroborated by the Prescott plots. Other questions that need to be answered are: How much will a given degree or frequency of thinning increase diameter growth, or, conversely, how heavily and how often must a stand be thinned in order to maintain a required rate of diameter growth; what will be the effect of thinning on form factor, and how do different types of trees respond to thinning? These questions cannot be answered in 10 years, nor by a few plots on one site.

As may be inferred, present thought in the Southwest favors special treatment of selected crop trees instead of the whole stand, on the theory that the low precipitation in this region places a drastic limitation on the number of trees per acre that can be carried to maturity. How many crop trees per acre are warranted, what types are most desirable, and how heavily or frequently must they be released from competition are questions that foresters are asking. The answer will be sought in future records of the Prescott plots and in a more comprehensive series of stand improvement plots recently established in the Fort Valley Experimental Forest.

Table 4

AVERAGE DIAMETER GROWTH IN 10 YEARS OF CROP TREES ON THINNED PLOT A AND UNTHINNED CONTROL PLOT B

D.b.h.	Number of crop trees on plot		Average height, 1935		Average diameter growth, 1925-1935	
	Thinned	Not thinned	Thinned	Not thinned	Thinned	Not thinned
	Number	*Number*	*Feet*	*Feet*	*Inches*	*Inches*
6	12	4	38.0	39.0	1.3	0.8
7	23	7	38.1	39.0	1.2	0.7
8	56	12	39.2	39.0	1.3	0.8
9	46	13	42.9	42.7	1.3	0.9
10	47	7	43.4	45.3	1.3	1.1
11	39	3	48.7	47.5	1.3	0.7
12	18		52.9	---	1.5	---

SOME RESULTS OF THINNING IN SMALL POLE STANDS OF PONDEROSA PINE IN THE SOUTHWEST

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The preceding article presented broadly the aims and results of thinning practices in the Southwest; this companion article carries the subject farther, with a detailed statistical analysis applied to thinning plots in ponderosa pine to determine the effectiveness of the "crop-tree" method of thinning widely used by the C.C.C. in that region.

THINNING is a phase of applied silviculture. Thinning, if properly executed, affords a means by which the forester may increase the growth rate on trees of the ultimate stand, perhaps shorten the rotation, and improve the quality of the stand by removing trees which are undesirable from the standpoint of species, quality, form, condition, or position in the stand.

The Study

In 1926 the Southwestern Forest and Range Experiment Station established a series of five thinning plots and two check plots in a 41-year-old natural stand of black jack poles (*Pinus ponderosa* Lawson). The plots are located within or near the Fort Valley Experimental Forest, in north central Arizona. The soil is of volcanic origin, locally referred to as "malpais". The plots have a southerly exposure and an elevation of about 7,700 feet.

A modified German method of thinning was used. Two degrees of thinning were made—narrow spacing and wide spacing. The trees removed from the stand were mostly of the suppressed and intermediate crown classes. However, diseased, defective, deformed, and "wolf trees" of the upper crown classes were also cut. Thining was done in such a manner as to leave the trees more or less uniformly distributed over the area. No attempt was made to thin to a definite spacing or to a definite number of trees per acre; however, the number of trees left per acre is a rough measure of the spacing. Plots A, B, and D were treated so that narrow spacing between stems was obtained. Plots C and E were given a wider spacing. Plots F and G were left in the natural state to serve as control plots.

In 1934 Region 3 of the U. S. Forest Service adopted the "crop-tree" method[1] of thinning in timber stand improvement. In order to obtain some information as to the possible effectiveness of this method, crop trees were selected on the above plots at the rate of 80 per acre. Both diameter and height measurements were taken on these selected trees during the summer of 1935 and an analysis was made of the diameter, basal area, and height increment for the 9 years since thinning. These plots were thinned by a method differing considerably in prin-

[1]This method calls for the selection of 80 crop trees per acre to be released from competition and pruned. Crop trees are selected whenever possible from the dominant classes. The trees are of good form, without disease or defect, and are spaced as uniformly 24 x 24 feet as possible. In releasing the selected crop tree the aim is to free the crown at the widest point on four sides at least 3 feet and not to exceed 6 feet, and yet maintain adequate ground cover. In case the crop tree is a codominant, its dominancy is assured by removal of the inferior dominant. This method aims at doing the minimum amount of work commensurate with securing the maximum benefit in the way of increased growth and quality in the final merchantable crop.

iple from the crop-tree method; never-heless, the following results may be ndicative of what may be expected from he crop-tree method.

The purpose of this paper is to deter-nine if thinning or width of spacing ignificantly increased the diameter, basal rea, or height increment of the selected rop trees.

METHOD OF ANALYSIS

It is impossible to determine by direct omparison whether the observed differ-nce between the means of plots and be-ween the means of treatments is due to reatment or to errors of sampling because f the small numbers of trees upon which ach mean is based. In order to determine f differences as great as those hereinafter bserved might be expected to occur in uch small samples by chance rather than s the result of thinning treatment, the ata were subjected to statistical analysis y methods described by Fisher[2] and by Bruce and Schumacher.[3]

RESULTS AND DISCUSSION

Table 1 gives the condition of the plots t the time they were established, both efore and after thinning. Plots C and originally had fewer trees per acre han the other plots; consequently fewer ees were removed to obtain the wide pacing effect.

The values in columns 10 and 11 of able 1 suggest that the crop trees on lots C and E, those thinned to wide pacing, were larger than the trees on e other plots at the beginning of the xperiment. To determine if this was ue, the diameter measurements of all op trees on plots receiving the same eatment were pooled in order to in-rease the number of observations. The ean d.b.h., standard deviation, and andard error of the mean were com-

TABLE 1

COMPARISON OF PLOTS AT BEGINNING OF EXPERIMENT, 1926

Plot	Treatment	Age	Area of plot	Number of trees per acre		Trees cut	Range of diameters		Average d.b.h.		Average spacing after thinning
				Before thinning	After thinning		Before thinning	After thinning	Before thinning	After thinning	
		Years	*Acres*			*Per cent*	*Inches*	*Inches*	*Inches*	*Inches*	*Feet*
A	Thinned, narrow spacing	41	0.0750	1338	813	39.2	1-9	2-8	4.6	4.9	7.3
B		41	0.1050	1861	867	53.4	1-9	1-9	4.3	4.9	7.1
D		41	0.0772	2047	984	51.9	1-11	2-11	4.3	4.9	6.6
C	Thinned, wide spacing	41	0.1541	638	363	43.1	2-11	3-11	6.4	6.6	10.9
E		41	0.1298	853	462	45.8	1-11	3-11	6.0	6.8	9.7
F	Control	41	0.0434	2373	...	0.0	1-7	...	3.5	...	4.3
G		41	0.0853	1254	...	0.0	1-9	...	5.0	...	5.9

[2]Fisher, R. A. Statistical methods for research workers. Edinburgh, fourth revised edition. . 114-117. 1933.

[3]Bruce, D. and F. X. Schumacher. Forest mensuration. pp. 74-86. New York. 1935.

puted for each of the treatments and are given in Table 2.

Statistical tests[4] were made to determine if the mean d.b.h. of crop trees receiving the wide spacing treatment was significantly greater than the mean d.b.h. of crop trees of the unthinned control. These tests show that the mean d.b.h. of the wide spacing was highly significantly[5] greater than that of the narrow spacing and than that of the unthinned control. However, the mean d.b.h. of crop trees of the narrow spacing and the control were not significantly different.

Diameter Increment

Diameter increment was used to determine the influence of thinning on the growth rate of crop trees. This procedure eliminated the size of the tree as a variable.

The mean d.b.h. increment, standard deviation, and standard error of the mean were computed for the crop trees of the two thinnings and the control. These data are given in Table 3. Statistical tests were then made to determine if a significant difference existed between the mean increments as computed for each of the three treatments.

It was found that the mean d.b.h. increment of crop trees on the plots of wide spacing was significantly greater than the mean d.b.h. increment of those on plots of close spacing, and highly significantly greater than the mean increment of crop

Table 2

COMPARISON OF THE MEAN D.B.H. OF CROP TREES AT BEGINNING OF EXPERIMENT, 1926

Treatment	Plots	Number of crop trees	Mean d.b.h.	Standard deviation	Standard error of the mean
		Number	*Inches*	*Inches*	*Inches*
Wide spacing	C and E	22	8.58	±1.1991	±0.2556
Narrow spacing	A, B, and D	20	6.98	±1.3994	±0.3129
Unthinned control	F and G	10	7.31	±0.6967	±0.2203

[4] In these tests the following formulæ were used:

Standard deviation: $\sigma = \sqrt{\frac{\Sigma\ (X^2)}{N-1}}$

Standard error of the mean: $\sigma_M = \frac{\sigma}{\sqrt{N}}$

Standard error of the difference: $\sigma_D = \sqrt{\sigma_{M_1}^2 + \sigma_{M_2}^2}$ $\quad t : t = \frac{M_1 - M_2}{\sigma_D}$

in which:

σ = standard deviation
Σ = summation
X = deviation of individual observations from the mean
N = number of observations
M = mean
D = difference between two means
t = ratio of difference between two means to standard error of the difference.

[5] In this paper the term "significant" and "highly significant" refer to the probability 0.05 and 0.01 respectively, i.e., to the probability that only once in 20 and only once in 100 other groups of similar samples a difference between means as great as or greater than those observed here might be expected to occur by chance. The significance of the difference between two means is determined by dividing the observed difference by the standard error of the difference and referring the quotient to a table of t-values to determine the probability. Fuller details concerning the use of t may be had from p. 112 of the reference given in footnote 2.

trees on the control plots. However, the mean difference between increments of the narrow spacing and the control is not significant.

Basal Area Increment

Volume increment is highly correlated with increment of basal area and height. Since it is desirable to determine the growth behavior of basal area and height after thinning, the following analyses were made on the basis of these variables rather than on the basis of volume.

The mean basal area, standard deviation, and standard error of the mean were computed for all crop trees of each treatment. These statistics are given in Table 4.

Tests were made between the wide spacing and narrow spacing means, between the wide spacing and control means and between the narrow spacing and control means. The results show that the mean difference between the basal area increment of the wide spacing and narrow spacings, also that between the wide spacing and control, is highly significant. However, the result indicates that the mean difference between the narrow spacing and the control is not significant, but that the basal area increment on plots of these two treatments is similar and that the observed differences between the two means could very easily be the result of chance variation.

Height Increment

Table 5 shows that there is very little difference in mean height increment between the means of treatments.

The differences between mean height increments for the three treatments were computed, analyzed, and tested by the same method. In no case did treatment prove to significantly influence height growth.

Inasmuch as this thinning experiment has run but 15 per cent of a cutting cycle (three cutting cycles per rotation), no attempt has been made to determine if thinning or width of spacing will materially shorten the rotation or increase the yield of the final merchantable crop. There seems to be a necessity for thinning experiments designed to control statistically and experimentally as many variables as possible.

Conclusions

In so far as the analyses of the growth on these thinning plots are concerned, the following conclusions may be drawn:

1. The diameters of crop trees on the plots thinned to wide spacing were larger at the beginning of the experiment than those on the other plots.

2. The mean d.b.h. increment of crop trees on plots of wide spacing was significantly greater than that of crop trees on plots of narrow spacing, and highly significantly greater than on the control plots.

3. The mean difference between d.b.h. increment of the narrow spacing and the control is not significant.

Table 3

Comparison of mean d.b.h. increment of selected crop trees for the 9-year period following thinning

Treatment	Plots	Number of crop trees	Mean d.b.h. increment	Standard deviation	Standard of error of the mean
			Inches	*Inches*	*Inches*
Wide spacing	C and E	22	1.141	±0.1436	±0.0306
Narrow spacing	A, B, and D	20	1.020	±0.2330	±0.0521
Unthinned control	F and G	10	0.920	±0.1683	±0.0532

4. The mean basal area increment of selected crop trees for the thinned wide spacing is highly significantly greater than that for both the narrow spacing and the unthinned control.

5. The mean basal area increment of crop trees of the thinned narrow spacing is not significantly different from that of the unthinned control.

6. The differences in mean height increment between all three treatments are not significant, and the height growth in all cases appears to tend toward similarity.

TABLE 4

COMPARISON OF MEAN BASAL AREA INCREMENT OF SELECTED CROP TREES FOR THE 9-YEAR PERIOD FOLLOWING THINNING

Treatment	Plots	Number of crop trees	Mean basal area increment	Standard deviation	Standard error of the mean
		Number	*Sq. ft.*	*Sq. ft.*	*Sq. ft.*
Wide spacing	C and E	22	0.1141	±0.0225	±0.0048
Narrow spacing	A, B, and D	20	0.0843	±0.0279	±0.0062
Unthinned control	F and G	10	0.0790	±0.0215	±0.0068

TABLE 5

COMPARISON OF MEAN HEIGHT INCREMENT OF SELECTED CROP TREES FOR THE 9-YEAR PERIOD FOLLOWING THINNING

Treatment	Plots	Number of crop trees	Mean height increment	Standard deviation	Standard error of the mean
		Number	*Feet*	*Feet*	*Feet*
Wide spacing	C and E	22	5.99	±1.0932	±0.2331
Narrow spacing	A, B, and D	20	6.00	±1.2937	±0.2893
Unthinned control	F and G	10	5.85	±0.8182	±0.2587

EFFECT OF INCREMENT BORING ON DOUGLAS FIR

By WALTER H. MEYER and STANTON B. HAYWARD

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A GREAT many trees are bored for determination of age and diameter growth without thought of the damage that may result to the trees. In order to obtain information on the reaction of Douglas fir to increment boring, a test was started in 1929 on 30 second-growth Douglas firs on the Wind River Experimental Forest, in southern Washington. The trees selected ranged from 6 to 20 inches in diameter and included dominant, codominant, intermediate, and suppressed individuals. Each tree was bored at breast height on four sides, to depths of from 5 to 6 inches. One hole was then plugged with a ⅜-inch maple dowel, one with a small twig taken from a nearby tree, and one with the extracted core. The fourth hole was left open. All four treatments had been recommended for preventing damage to the tree.

In the fall of 1934, five years after the borings were made, 15 of the test trees were felled and 12- to 24-inch sections of their boles, containing the boring holes, were saved off. Tangential cuts were made over each hole, the first approximately ½ inch, the second 1½ inches, and the third about 3½ inches inside the bark. In a few sections of larger trees one or two additional cuts were made, at 2-inch intervals. The inner face and upper and lower ends of each slab were examined closely. All abnormalities that might possibly be related to the borings were recorded and were sketched to scale.

Observations of tangential sections showed that each hole was slightly more than ⅜ inch in diameter. The hole was invariably surrounded by a shell of crushed wood from 1/20 to 1/10 inch thick. Except at the extreme outer end, the hole never fills with woody tissue. It is conceivable that before the outer end of the hole is closed by a callus insects and fungi may find entrance. So far as could be determined by ocular examination, however, this had not taken place in any of the 15 samples examined. In the majority of cases, the outer end of the hole was completely filled with hardened pitch. This was noted in the small suppressed trees as well as in the larger, more vigorous trees. Hardening of pitch extended to a depth of from ¼ inch to 1½ inches. The larger trees had exuded more pitch than the smaller.

The maple dowels were all found to fit tightly, and were sound with two exceptions. No callus had as yet started to grow over the end of any of the dowels. The twigs either fitted the holes very closely or else were firmly held by hardened pitch, and all but two were sound. In one vigorous 13-inch tree, the hole plugged with a twig was completely grown over. The replaced cores were firmly held by hardened pitch in all trees but 5, in which the pitch had not yet hardened. Calluses had grown over the cores in 5 trees, completely covering the cores and holes. In 13 trees the holes left unplugged were completely filled at the outer end with pitch, which had hardened in 11 trees. In 5 the holes had been completely grown over, and in 8 they were nearly covered by new wood tissue.

All the dowels, many of the twigs, and some of the cores had been left extending a short distance beyond the cambium, and so had prevented early

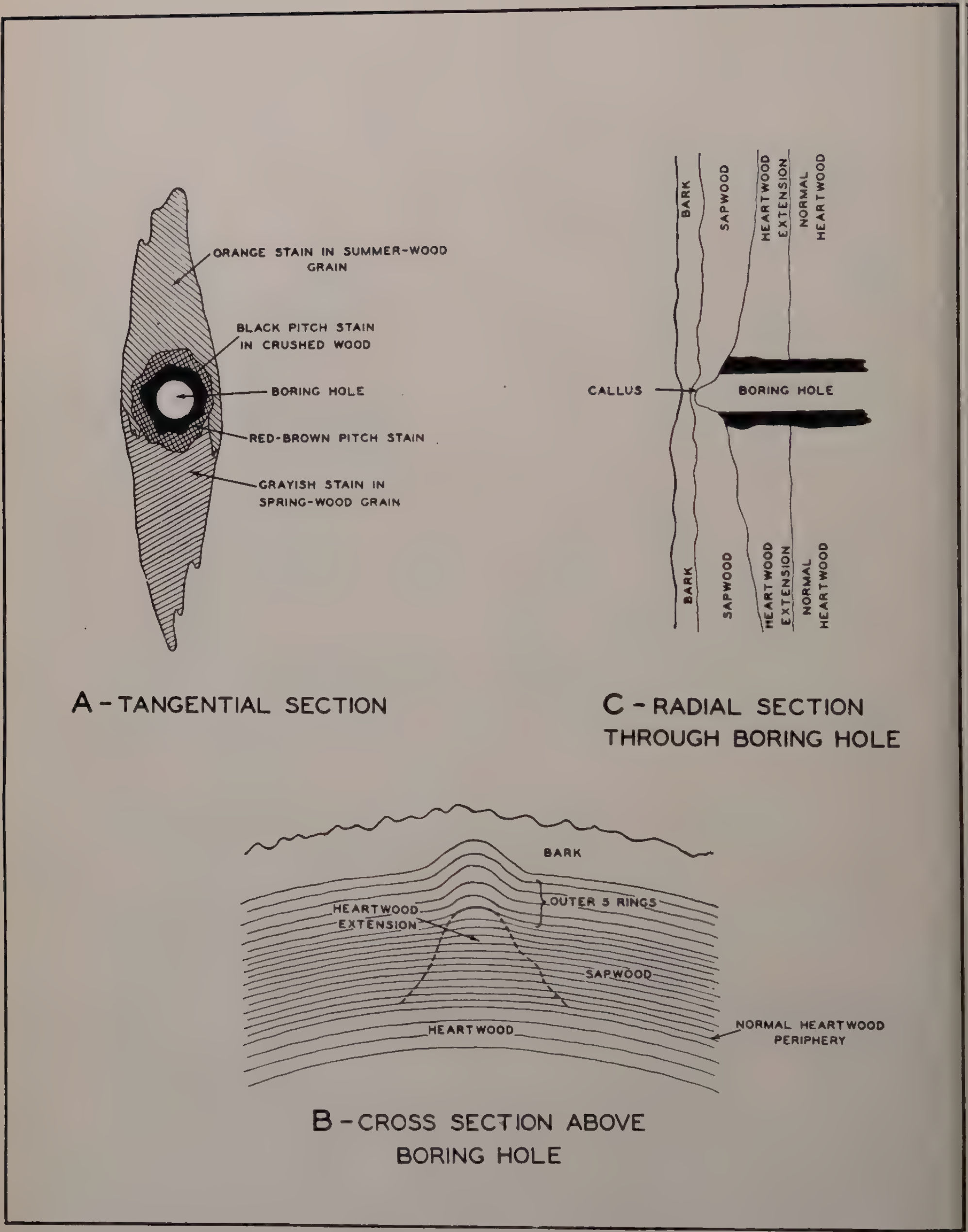

Fig. 1.—Typical effects from increment boring of Douglas fir.

formation of a callus. If the ends of the plugs had all been cut off flush with the inner cambium, it is very probable that practically all the holes would have been completely covered by new wood growth within the five years after the boring.

In general, staining of the wood surrounding the boring holes showed very slight difference with treatment. The typical condition was dark, heavy pitching of the crushed wood, red-brown staining of a surrounding ring, and light-red to gray staining of an elliptical area (Fig. 1, A). The intermediate ring was generally grayish in the spring wood and red-brown to glossy black in the summer wood. The ellipse was never more than 1 inch in horizontal extent, but often reached to the ends of the sections examined. This lighter stain tended to decrease in extent and intensity toward the center of the tree. The intensity and extent of the pitch stain were greatest in the larger dominant trees and least in the small suppressed trees.

Boring caused transformation of sapwood to heartwood in nearly all cases for a varying distance upward and downward from the hole (Fig. 1, B). The extension of the heartwood periphery lessened gradually as vertical distance from the hole increased (Fig. 1, C). In a few trees some extension was noted at least 10 inches above and 10 inches below the hole. In others no extension was evident 6 inches from the hole. In the majority of cases, extension continued farther above the hole than below. The amount of lateral extension of the heartwood was greatest in the larger trees, owing to the greater width of the annual rings in their sapwood. The number of rings in the heartwood extension showed no significant correlation with tree size or crown class. Amount of extension, either laterally or vertically, seemed to vary little, if at all, with treatment.

In some cases the outer three to five rings were abnormally enlarged to a varying distance above and below the boring hole (Fig. 1, B). This peculiarity was observed in seven sections containing unplugged holes, five containing dowel-plugged holes, four containing twig-filled holes, and four containing core-filled holes. Resin ducts were abnormally abundant directly over and under the boring holes, especially between the 1929 and 1930 annual rings.

The effect of the increment boring on the trees can be summarized as follows: (1) staining of the wood around the hole by free resin; (2) extension of the heartwood periphery; (3) acceleration of growth in the immediate vicinity of boring holes; and (4), usually, formation of callus over unplugged holes. The results show beyond a doubt that boring holes in Douglas fir trees need not be plugged but may safely be left open, since they will be closed naturally by hardened pitch within a very short time and by new wood tissue within a few years. A further argument against inserting plugs in the holes is the probability that the plugs, like broken branch stubs, offer fungi a means of direct entrance into the heartwood. The formation of pitch in the unplugged hole prevents the entrance of either insect or fungus.

The damage resulting within five years from increment boring has relatively little effect on the life of a Douglas fir tree and its subsequent value for lumber. Only a small part of the tree is affected.

Only half the trees treated in this experiment were felled and studied in 1934. It is planned to continue the test by felling some of the remaining trees, and making further observations of the damage, in 1939 and 1944.

APPLICATION OF THE KOCH PROFILE METHOD IN THE CONSTRUCTION OF VISIBILITY MAPS

By CLEMENT MESAVAGE

Department of Forestry, Pa. State College

The principle of profile mapping was discovered long before it was used to locate visible areas from existing or potential forest observation stations. During the past decade several independent investigators have experimented with various techniques in an attempt to develop working methods that would combine rapidity with simplicity of application. Considerable work has been done in western National Forests, particularly by the California Forest and Range Experiment Station.[1] The author suggests a technique for applying the Koch profile method in the construction of visibility maps.

In the Koch profile method, a topographic map is used from which profiles are drawn along various radii starting from the point on the map as a center. Visibility along these profiles is then indicated by drawing lines of sight from the lookout through points high enough to intersect the line of sight in the same vertical plane. Obviously any area under the line of sight and beyond an intersecting high point is invisible. Such outer edges of invisibility are marked directly on the profile for each line of sight. The profile is then transferred to its corresponding radius and the invisible areas are transferred to the radius drawn on the map.

If a profile along only one radius is drawn, it is sufficient to indicate visibility along this one line only. If several radii are drawn, however, the points along each radius can be connected with points on the other radii. It is assumed that the condition of visibility is uniform between points on adjoining radii, but the line of demarcation can be changed when needed changes are apparent after reading the topography.

The profiles serve as a sample; therefore, accuracy can be increased by taking a larger sample (drawing more profiles). Since the distance between radii (chord or arc) increases progressively with the distance from the center, it is clear that it may be necessary to draw intermediate profiles as the circumference increases, in order that the sampling may be more uniform over the entire area. (Fig. 1.) In actual practice, the accuracy desired will dictate the number of profiles to use. More profiles will be needed in broken country than in areas where more uniform conditions prevail.

When visibility maps are prepared for the observation of forest fires, the fact that smoke can be seen issuing from an invisible area is taken into account.

Fig. 1.—With the same number of profiles, the inner area has better sampling than the outer.

[1]Brown, A. A. Improving forest fire detection in California. Jour. For. 33: 923-931. 1935.

Areas of this nature are appropriately termed "indirectly visible areas". How far below the line of sight a fire may occur and still be classed as indirectly visible depends on the distance from the eye, degree of visibility, and volume and character of smoke. Ordinarily invisible areas not more than 200 feet below the line of sight are considered to be indirectly visible.

System of Application

The following materials are needed:

Drawing board.

T-square.

Topographic map of the area.

Paper graduated full-circle protractor with a diameter great enough to extend beyond the confines of the map when the lookout point is placed over the center of the circle.

Ruled pad with lines long enough to accommodate the longest profile.

Soft celluloid straight edge longer by several inches than the diameter of the circle.

Celluloid line indicator.

4 steel thumb tacks.

2 fine thumb tacks with flat glass heads.

5-H pencil.

Colored pencil, red on one end and blue on the other.

The map is lightly pasted by the corners so that the center of the circle is accurately under the lookout point. The map must be within the circle in order that the graduations of the circle can be seen. For this reason, the circle must be large enough. In the event the map embraces more territory than would be within the range of visibility, it may be cut down to fit. The materials are arranged as shown in Figure 2.

The celluloid straight edge and the lines of the pad should be fixed parallel with the end of the drawing board. The circle is staked to the drawing board by a glass thumb tack through the lookout point so that the map and protractor may

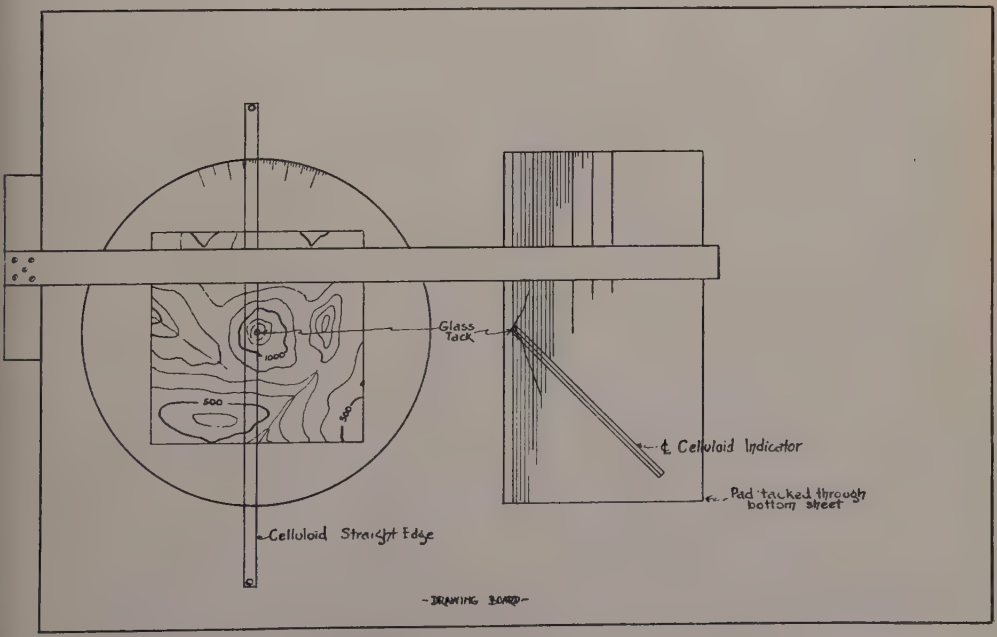

Fig. 2.—Materials required to draw profiles arranged as used.

be turned around the tack. The celluloid straight edge should run directly through the center of the lookout point. Its edge forms a line along which a profile may be drawn, the points being transferred to the ruled pad by projection with the T-square.

The ruled lines of the pad represent intervals in elevation corresponding to the contour interval of the map. When all points for a given profile are plotted, they are connected. Whenever it is apparent that the condition of topography between two successively plotted points on a profile is not uniform, interpolations should be made immediately in order to promote accuracy and to minimize confusion.

After the profile is drawn, the next step is to determine the areas of visibility, indirect visibility, and invisibility. To do this a flat glass-headed thumb tack is placed on the profile at the elevation of the lookout. The celluloid line indicator is then hooked to this tack so that it is free to swing on the point. The center line of the indicator corresponds to a line of sight. Starting at the upper end of the profile, the indicator is swung until it follows the highest line of sight. While the indicator is in this position, the T-square is used in transferring the visible, indirectly visible, and invisible areas back to the line from which the profile was plotted. This is simplified by the fact that any given point on the profile is defined on the map by the intersection of the T-square and celluloid straight edge.

The invisible areas should be drawn along the line in blue or some other dark pencil, those indirectly visible in red, and the visible areas left clear. When these areas are indicated on the line from which the profile was drawn, the circle is turned a desired interval and the straight edge forms a new line from which the next profile is projected. In U. S. Forest Service usage this interval is 2½ degrees within a radius of 10 miles, and 1 degree for the remainder of the range of visibility.

When the profile sheet is filled, it is torn off and thus a clean sheet is available. The holes made by the tack may be used again as the height of the lookout. Sheet space can be conserved and more profiles drawn on one sheet if they are squeezed together by having the vertical scale of one profile overlap the scale of the profile beneath it. This is especially true when the interval turned is small, since the profiles do not change very materially.

After a little practice this arrangement expedites the work, and very little waste motion is necessary.

Since the country is always visible through the transparent celluloid, plotting is accurate and simple.

EARLY SURVIVAL OF SOME PINE INTERPLANTINGS IN SOUTHERN NEW JERSEY

By O. M. WOOD

Allegheny Forest Experiment Station

One method of handling the inferior sprout hardwood stands of the New Jersey coastal plain has been to clear cut and plant the openings among the stumps with coniferous seedlings. In this paper the history of several thousand pine seedlings, interplanted during the years 1930 to 1933 inclusive, has been followed through the 1934 growing season.

REPEATED fires and cuttings have reduced the forests of the New Jersey coastal plain to poorly stocked coppice stands of pine and hardwoods. On the State Forests such stands have been clear cut when they reached fuel-wood size, and the openings among the stumps have been planted promptly with coniferous seedlings.

To determine the value of this method as a silvicultural system for improving the South Jersey forests, the Allegheny Station established several interplantings during the years, composed of the species shown in Figure 1.

The Planting Site

These interplantings were made in the Camp Ockanickon Experimental Forest, just within the western edge of the "Pine Barrens", where the soil, although somewhat better than those of the region as a whole, are nevertheless sandy and as a result are well to excessively drained. Normally the rainfall of this region is abundant, and temperatures are not extreme. The abnormal weather that has prevailed during the life of the interplantings will be discussed later.

Prior to planting, the site supported a seven-year-old stand of sprout chestnut and white and black oaks (*Quercus montana* Willd., *Q. alba* L., and *Q. velutina* Lam., respectively), with a few other hardwoods and pitch pine (*Pinus rigida* Mill.), all of which were growing vigorously. Except on a fenced half-acre plot clear cut in 1931, recut each year since, and included here for purposes of comparison, the interplantings were made in the openings among the sprout clumps of this stand.

Stock and Methods of Planting

The stock interplanted was grown in the state nurseries of New Jersey and Maryland, and was donated by them for the purposes of this experiment. Unfortunately it was not possible to obtain the species desired every year, hence not all the plantings could be replicated. Only the stock planted in 1933 was known to have been grown from seed collected in southern New Jersey. Some of the stock, notably the shortleaf pine (*Pinus echinata* Mill.) received in 1930 and 1931, and the 2-0 loblolly (*P. taeda* L.) received in 1931, had been frost-damaged in the nursery. The Norway pine (*P. resinosa* Sol.) planted in 1931 and in 1932 was small and otherwise in poor condition when received.

Very small or injured seedlings were discarded. The remainder were planted not less than 6 feet from sprouting hardwood stumps or from the edge of the crown of living trees, by two-man crews, using a modification of the slit method. They were set at approximately the same depth as they had occupied in the nursery.

The planting site was broken by roads, streams, and older stands into irregularly shaped areas. Each of these was interplanted with a single species in 1930 and 1931. In 1932 only about 1 acre of new interplantings was established. The remainder of the seedlings planted that year, and all of the 1933 seedlings, were used to replace the dead trees in the 1930 and 1931 plantings. Uniformly spaced rows could not be maintained, and the number of trees interplanted varied from 90 to 192 per acre. Including replacements, a total of 10,054 seedlings were interplanted over an area of 40 acres. On the one-half acre fenced plot cleared in 1931, 625 trees were planted in 1932, spaced 6 feet by 6 feet.

The plantings were examined in April and August, 1930, and in the fall of each year thereafter, including 1934. Future observations will probably be made at five-year intervals. Parts of the plantations were visited daily for the collection of meteorological and other data.

Individual records, consisting of initial height, height growth, and condition, have been kept for each seedling planted. Note was also made of the natural pine seedlings which have appeared near the interplanted pines, although the number observed has been insignificant.

Survival, and Factors Affecting It

In Figure 1 the total loss of each species by seasons after planting, and the final survival in 1934, have been shown. It will be noted that there is a wide range in the survival of those species planted the same year, as well as among the same species planted in different years. Also, with two exceptions, the first season loss is greatest, and with a few further exceptions, the losses decrease in each succeeding year after planting.

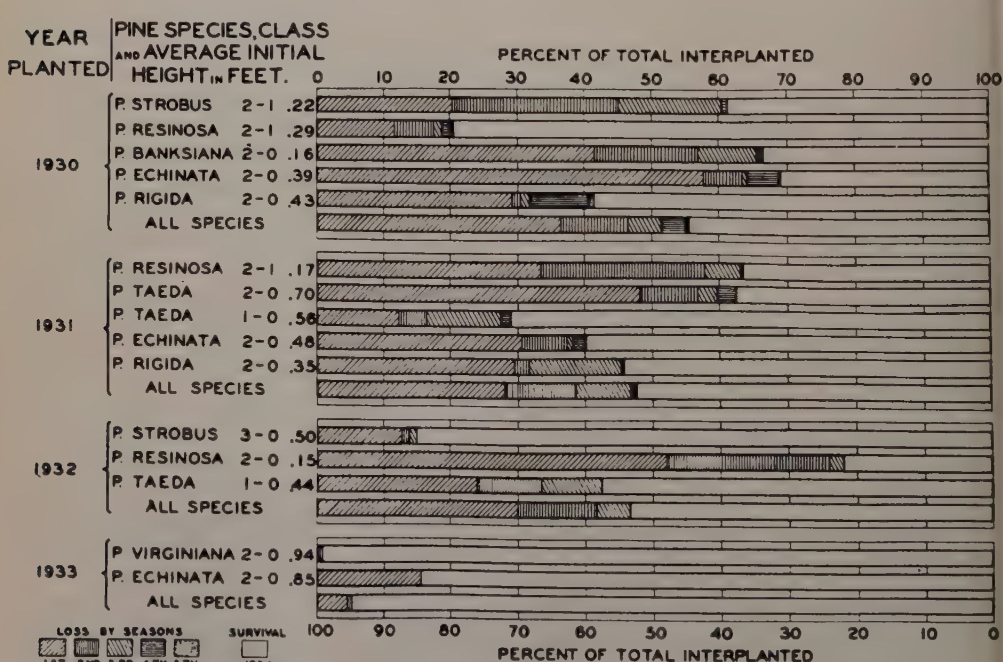

Fig. 1.—Loss and survival of interplanted seedlings through 1934.

Because of the great number of variables encountered in a plantation study, the difficulty of ascribing the death of a seedling to any factor alone is fully realized. However, in most cases some concrete evidence was found that linked the initial injury with a single factor.

Climatic Factors, Condition of Planting Stock, and Survival

Direct evidence of climatic injury was afforded by a low temperature reached in June, 1932, which killed the new shoots of loblolly pine. The trees soon outgrew this injury, however, and loblolly, although a southern species, was not affected by an extreme low of —25° F. reached in February, 1934.

Evidence that drought has killed many of the seedlings is largely circumstantial, yet may be almost incontrovertible—as is shown in Table 1. Here the 7-months precipitation and number of storms for 1930-33 have been compared with the first-season loss of all species other than that ascribed to biotic factors. The normal precipitation for this period as shown by the records of a nearby Weather Bureau station is 28.92 inches.

The losses in this table include those trees which were so small or lacking in vigor when planted that they were unable to withstand unfavorable weather conditions. Many of the shortleaf planted in 1930, the Norway and 2-0 loblolly planted in 1931, and the Norway planted in 1932 were in this condition. It will be noted from Figure 1 that the first season loss of these 4 lots of stock is high. It was particularly so for the shortleaf. Although this species was culled heavily before planting, 41 per cent of it failed to grow at all and an additional 16 per cent died the first summer. Loss of the other species planted in 1930, ascribed to condition of stock, ranged from 2 to 11 per cent.

Next to the 1930 shortleaf in order of magnitude of first-season loss was the Norway pine planted in 1932. It will be noted in Figure 1 that this stock was the smallest planted in any year.

From the height figures presented it will also be noted that age, class, and height of the stock are not directly related even within a species. One-year-old loblolly are taller than two- and three-year-old Norway and white pines, 3-0 white pines are taller than 2-1 white pines.

That there was a relationship between height and survival was shown by grouping all species planted in 1930 by 0.1 foot height classes and recording loss and survival. At the end of the first growing season 72 per cent of the 0.1-foot class were alive, and 85 per cent of the 0.8-foot class. By 1934 survival for the original 0.1-foot height class had dropped to 18 per cent, but for the 0.8 class remained as high as 56 per cent. Barring injury in the nursery, the largest seedlings in any one lot of stock and, among different lots, the largest rather than the

Table 1

PRECIPITATION AND FIRST SEASON LOSS EXCLUSIVE OF THAT ASCRIBED TO BIOTIC FACTORS

Year	March to September inclusive			Loss
	Maximum drought period	Storms	Precipitation	All species
	Days	*Number*	*Inches*	*Per cent*
1930	23	55	20.77	32.7
1931	13	77	27.06	26.4
1932	13	62	25.80	17.3
1933	8	78	40.78	4.0

oldest are apparently most likely to become established.

Even the largest and most vigorous specimens must have been adversely affected by the deficiency in the 1930 rainfall. The 23-day drought period recorded in 1930 occurred from April 21 to May 13, that is, at a time when the newly planted seedlings were just beginning growth. At the end of this period soil moisture in the top 6 inches was as low as 2 per cent in places, which was near the wilting point for these soils.

Of the stock planted in all years no less than 6 per cent failed to make any growth after planting. An additional 25 per cent died after planting as a result of unfavorable weather conditions aggravated by the poor condition of the stock when planted. About 4 per cent showed drought injury but were not killed.

Vegetative Competition and Survival

Competition offered by the natural vegetation of the site is always a critical factor in the early survival of a plantation, and it is particularly so in an interplanting where this vegetation is already well established. Competition is also closely linked with prevailing climatic conditions, particularly drought. To measure the effect of this competition, the hardwood sprouts within the fenced plot mentioned early in the report were cut back each year. In Table 2 the 625 pines planted inside the fence in 1932 are compared with an equal number selected at random from those planted the same year outside the exclosure. Both lots had the same average initial height.

Seedlings injured by animals were not included in the sample outside the fence, because there was no animal injury inside. Apparently white pine (*Pinus strobus* L.) withstands competition better than the two other species, although the higher survival of this species may be partly due to its greater initial height. White pine also is generally known to be more shade tolerant than any of the hard pines.

Biotic Factors and Survival

Insects and Diseases.—Survival of the interplantings has not been greatly affected by insects. Such damage as has occurred was caused either by the Nantucket tip moth (*Rhyacionia frustrana* Coms.) or by one of the false pine web worms. Of the two, the tip moth causes the more serious damage and it was increasing in the interplantings until seemingly checked, for a time at least, by the extremely low temperatures of 1934. White pine weevil, although reported in older plantations in southern New Jersey, has not appeared in these interplantings. In all, less than 1 per cent of the seedlings died as a result of insect attack, although 14 per cent were injured.

The only diseases recognized in the plantations to date are the sweet fern blister rust (*Cronartium comptoniae*,

Table 2

SURVIVAL AND GROWTH ON CLEARED AND UNCLEARED SITES, AS OF NOVEMBER, 1934

Species of pine	Average initial height	Planted each site	Survival		Mean annual height growth	
			Cleared	Uncleared	Cleared	Uncleared
	Feet	*Number*	*Per Cent*	*Per cent*	*Feet*	*Feet*
White	0.6	210	97.1	94.3	.49	.43
Loblolly	0.4	206	97.1	83.0	.93	.40
Norway	0.1	209	87.6	30.1	.25	.09

Arth.), and a Coleosporium needle rust, probably *C. solidaginis* (Schw.) Thum. Neither of these are at all common, however, and their effect on survival has been negligible.

Animals.—The effect of animal injury on survival, at least for some species, has been anything but negligible. The 1932 loblolly pine and the 1930 white and jack pines suffered most, with 27, 22, and 23 per cent, respectively, killed and 22, 15, and 34 per cent injured. The death of all other species caused by animals was under 10 per cent, although total injury of the 1930 and 1931 pitch pine was 16 and 24 per cent, respectively. Only 1 per cent of the Virginia pine (*Pinus Virginiana* Mill.) planted in 1933 was injured by animals, and none were killed. Most of the damage by animals occurred during the first winter after planting. An exception to this was the jack pine (*Pinus banksiana* Lamb.) planted in 1930. This species began growth about the middle of April and furnished the only green vegetation present at the time, consequently it was badly damaged early in the spring and the first season loss was high, as is shown in Figure 1. This emphasizes the folly of planting an "exotic" whose growth habits are not adapted to the local climate. Much of the increased second-season loss of the 1930 white pine shown in Figure 1 was due to animal damage the first winter after planting.

Of all species planted during the four years, 8 per cent were killed by animals and an additional 8 per cent were injured.

Most of the animal damage was apparently caused by the rabbits which are common within the area interplanted, rather than by the deer which are seen occasionally there. Evidence to support this assertion has been presented in Technical Note No. 4, "Animal Damage in Relation to Size of Planting Stock", previously distributed in mimeographed form by this Station.

Summary and Conclusions

The individual history of several thousand pines, interplanted during the years 1930 to 1933, inclusive, on cut-over hardwood land, has been followed through the 1934 growing season. Of this number 6 per cent were in such poor condition when planted that they did not begin growth, 25 per cent succumbed to unfavorable weather conditions, chiefly drought intensified by root competition, 8 per cent were destroyed by animals, and slightly less than 1 per cent were killed by insects. The remainder, 60 per cent of the total planted, were alive in 1934, but many of these had been injured by one or more of the agencies mentioned above, so that only 36 per cent of the total number planted, or about 45 trees per acre, were alive and vigorous at the end of the 1934 growing season. Some further losses, although progressively fewer with the passing years, are unquestionably to be expected, and liberation cuttings are certain to be needed to keep the planted pines growing vigorously.

Upon first examination, accomplishment in this silvicultural operation appears hardly to justify the effort, even though the New Jersey Forest Service calculates the initial cost of its interplantings on state land to be as low as $2.25 per acre (based upon a million trees interplanted in 1936). However, it must be remembered that the site was already partly occupied by a sprout hardwood stand which, since the planting, has been extending root and crown into the openings interplanted, and that meanwhile practically no pine seedlings have come in naturally. The proportion of softwood seedlings in the present stand has therefore been substantially increased by the interplanting. Furthermore, some of the species of pine introduced are, at least within their natural range, superior to the native pines.

Because of the annual variation in weather conditions and the differences in species, condition, and age of the stock planted each year, comparison of the performance of one species with that of another can only be made with caution. Species such as jack pine, the natural range of which is far from the planting site, cannot be recommended. Virginia pine, although not previously planted in southern New Jersey, apparently deserves more consideration; survival has been extremely high, in spite of the fact that it was planted nowhere except in the exact spots where seedlings of the other species had died. Stock of this species grown from local seed has survived better than shortleaf pine, planted in the same year and also grown from local seed.

Apparently only large, vigorous seedlings of any species should be used in an interplanting. In this study, losses even after five growing seasons were still greatest within that class of seedlings having the smallest initial height.

The seriousness of rabbit damage in these interplantings indicates that reduction in the rabbit population is desirable.

SMITH RILEY died in Denver, August 2, 1936. He was buried in the Congressional Cemetery, Washington, D. C., on August 6. He served as District Forester in charge of National Forest District No. 2 from 1908 to 1919. For the past several years he has been in retirement on account of ill-health. He was one of the real old timers in the forestry and conservation field. A fuller outline of his life and professional career will appear in an early issue of the JOURNAL OF FORESTRY.

SEEDLING-SPROUT GROWTH OF SHORTLEAF AND PITCH PINE IN NEW JERSEY

By E. B. MOORE

New Jersey Department of Conservation and Development

THE upland forest of the coastal plain sands of southern New Jersey is made up of a mixture of oak and pine. The most common trees found in this type are white, black, scarlet, chestnut, black jack, and post oaks, which occur in varying degrees of mixture with pitch and shortleaf pine. As a result of cutting and fire the better sites have been converted largely to the arborescent oaks, the poorer ones to pitch pine and scrub oak. The oak element in these stands is largely of sprout origin, and of very poor quality, maturity apparently being reached between 40 and 50 years with diameters of 10 to 12 inches and heights of about 50 feet. Stands cf this age have usually begun to break up, and if cut show a high percentage of butt rot and borer work, even when there is no history or indication of fire during the current rotation. The stumps, in addition, are usually swollen and unhealthy in appearance, and show evidence of repeated coppice and frequent fires. Oak on the coastal plain sands rarely develops into anything of higher merchantability than cordwood or small poles, whereas pine, in spite of frequent fire damage, usually produces small saw-log material, with diameters up to 18 inches and heights of 60 feet in 70 years.

The repeated burnings to which this section of the state have been subjected in the past would seem to have seriously upset the biotic community,[1] as satisfactory seedling reproduction of the arborescent oaks is rarely successful, while at the same time progressive deterioration of the sprout stands is under way. The patches of bare sand which frequently develop around exhausted stumps further testify to the general chaotic condition of plant succession, while elsewhere the dense ground cover of blueberry, huckleberry, laurel, and scrub oak contribute toward limiting the reproduction of pine.

In the attempt to arrest further deterioration toward desert conditions on the coastal plain sands, the New Jersey Department of Conservation and Development several years ago started to develop a system of management to introduce more pine in decadent oak stands after clear cutting. Protection against fire was aided by safety strips of uncut oak surrounding each block. This practice was initiated in 1922 by Willis M. Baker,[2] then Associate State Forester, and had as its object the increase of pine in the stand on account of its superior rate of growth and merchantability, while at the same time the oak growth was continued for its protective and soil-building values. In practice this system was applied by clear-cutting the oak in stands of 40 to 50 years, followed by the planting of pine seedlings in the openings between the stumps where they would be least subject to early overtopping by the rapid juvenile growth of the hardwood

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[1]Taylor, W. P. Significance of the biotic community in ecological studies. Quart. Rev. Biol. 10: 291-307. 1935.

[2]Baker, W. M. Suggestions for forest management of the South Jersey coastal plain. Unpublished ms. in files of New Jersey Department of Conservation and Development. 1928.

sprouts. From 300 to 500 pines were planted per acre, and one or two cleanings of oak sprouts were usually necessary during the first 5 or 6 years, to prevent suppression. Beginning in a limited way in 1922, this program has been continued up to the present. During the last few years between 800,000 and 900,000 seedlings have been planted annually on the State Forests in South Jersey.

In this work a variety of species, both native and exotic, have been tried out. Austrian, Scotch, jack, red, and ponderosa pine, European and Japanese larch, Douglas fir, and Norway spruce are introduced species which have not shown satisfactory adaptability to local conditions in most instances, as might have been expected. On the other hand, two-year seedlings of pitch, shortleaf, and loblolly and three-year transplants of white pine have all given reasonably good results, and for the last few years have made up the bulk of the planting stock.

In the spring of 1930 particularly bad fire conditions developed in South Jersey, during which some of the recently planted areas on the State Forests were burned over and the young trees killed back to the ground. The question then arose as to whether or not it was necessary to replant blocks upon which either pitch or shortleaf pine seedlings had become established. It had frequently been observed that these species, if killed back by fire during the sapling or pole stages, would sprout vigorously, but usually developed into crooked, undersized individuals, having little commercial value. It was thought that younger stock, an inch or two in diameter at the ground, might follow this same course, although the work of Leffelman and Hawley[3] with hardwoods suggested that pitch and shortleaf pine of this size might very possibly develop into "seedling-sprouts" which would be as good as the original seedlings. Earlier observations of the native yellow pines by W. M. Baker[4] substantiated this.

To obtain definite information for guidance in planting plans, a permanent one-half acre plot was established on a burned-over area on the Bass River State Forest in southern Burlington County, in the winter of 1930. The oak on this tract had been clear-cut in 1926, leaving the few pitch pine which were present still standing. In the spring of 1927 the area was planted to a mixture of red pine and Japanese larch, which resulted in complete failure due to a protracted drought. In the spring of 1928 shortleaf pine(2-0) was planted, and established itself satisfactorily. Prior to the fire of May, 1930, this plantation averaged about 2 feet in height, and although in need of a cleaning was otherwise in good condition. Some natural pitch pine reproduction was present, and was slightly taller and more thrifty than the planted shortleaf. It is quite possible that this pitch pine had seeded in shortly before the cutting, and had been cut back or burned during these operations, so that in May of 1930 it was already "primary" seedling-sprout stock. When the plot was laid out in December, 1930, eight months after the fire, dense clusters of sprouts had developed from the root collars of all the pine seedlings. These sprouts reached a maximum of 1.5 feet in height, and little differentiation between leaders and laterals was yet apparent. The new oak shoots at this time were from 2 to 4 feet tall.

Each clump of pine sprouts on the plot was mapped, numbered, and tallied

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[3]Leffelman, L. J., and R. C. Hawley. Studies of Connecticut hardwoods. The treatment of advance growth arising as a result of thinnings and shelterwood cuttings. Yale Univ. School of Forestry Bull. No. 15. 1925.

[4]Loc. cit.

according to species, maximum height, and general condition or thrift (good, fair, poor). Pins made from No. 11 galvanized wire about 15 inches long, with numbered aluminum tags attached, were pushed into the ground beside each seedling. The tally at this time showed 478 pines per acre, of which 65 per cent were shortleaf and 35 per cent pitch. Thirty-seven per cent of the pines were reported as being in "good" and 50 per cent in "fair" condition. The slight superiority at this time of pitch pine in both thrift and height is indicated in Tables 1 and 2.

One year later, in the fall of 1931, the plot was remeasured. The results showed a surprisingly low rate of loss, approximately 5 per cent, and an accompanying improvement in the general thrift, with 43 per cent of the pines recorded as "good," a gain of 6 per cent. Pitch pine again excelled in both vigor and height growth. It was observed at this time that one shoot from each sprout-cluster was definitely developing into a leader, while the rest of the original clump spread out in a thicket of laterals on the ground. There had been a heavy infestation by native tip moths (*Rhyacionia* sp.) throughout the coastal plain during this season, and approximately 90 per cent of the plantation showed injury, both leaders and laterals having been attacked.

During the summer of 1932 the plot received a partial cleaning, the hardwood sprouts at this time having attained heights of 8 to 10 feet. Measurements taken in the fall of 1932 showed a loss of 6 per cent for the 2 years since establishment. Continued improvement in vigor is shown in Table 2, with 52 per cent of all pines reported as in "good" condition, and pitch pine increasing its favorable position.

In 1933 and 1934 the demands of other work interrupted the study, and no measurements were taken. However, a thor-

TABLE 1

PERCENTAGE OF SEEDLING-SPROUTS OCCURRING IN EACH HEIGHT CLASS

Height class	Shortleaf pine				Pitch pine				Total			
	1930	1931	1932	1935	1930	1931	1932	1935	1930	1931	1932	1935
Feet	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Under 0.5	51	14	4	...	37	14	4	...	46	14	4	...
0.5-1.4	46	44	18	6	56	31	13	4	49	39	16	6
1.5-2.4	3	40	61	12	7	52	46	10	5	44	56	11
2.5-3.4		2	14	20		2	30	4		2	20	15
3.5-4.4			2	20		1	6	27		1	3	22
4.5-5.4			1	25			1	17			1	22
5.5-6.4				11				20				14
6.5-7.4				4				11				7
7.5-8.4				1				5				2
8.5-9.4				1				2				1
Total	100	100	100	100	100	100	100	100	100	100	100	100
Av. height, feet	0.8	1.1	1.8	4.2	0.9	1.3	2.1	4.9	0.8	1.2	1.9	4.4

ough cleaning was made during the summer of 1934 by C.C.C. labor.

In the winter of 1935-36 the plot was measured for the fourth time. It was found that the total mortality in both pines during the 5-year period of the study amounted to 8 per cent, a very satisfactory record. In general thrift a steady improvement occurred in both species, 67 per cent now being tallied as "good," a gain of 30 per cent in 5 years. In survival, general thrift, and rate of growth pitch pine showed consistently better results. Both species show some effects of tip moth attack. This damage, however, has been widespread throughout the coastal plain—another indication of a disrupted biotic balance—and is no worse on the plots than elsewhere. On the whole these two pines seem to have made a good showing, in spite of the particularly injurious effects of a late spring burn.

Conclusion

The ultimate poor form, size, and growth of pine sprouts arising from trees 4 inches or more in diameter is believed to be almost certain. In the case of seedling-sprouts, however, it is thought that there is a possibility for the development of good, sizeable trees.

While this study is undoubtedly based on a limited number of measurements, the results are believed to be sufficiently significant to justify at least a partial reliance on the sprouting recovery of these species, under similar conditions, whenever a revision of planting plans becomes necessary in this region.

Table 2

PERCENTAGE OF SEEDLING-SPROUT IN EACH CONDITION CLASS

	Shortleaf pine				Pitch pine				Total			
Class	1930	1931	1932	1935	1930	1931	1932	1935	1930	1931	1932	1935
Good	37	41	47	62	37	49	61	77	37	43	52	67
Fair	47	39	34	21	57	36	23	14	50	38	30	19
Poor	16	20	19	17	6	15	16	9	13	19	18	14
Total	100	100	100	100	100	100	100	100	100	100	100	100

BRIEFER ARTICLES AND NOTES

More on Rules of Thumb

In the current discussion of rules of thumb, somewhat complicated methods for calculating log contents by Scribner and International rules have been advanced. Another viewpoint might be welcomed, or at least furnish basis for more argument.

In regard to rules of thumb in general, it is to be expected that if we go on a scaling job we will have the necessary equipment; but some quick, easy way of obtaining a close approximation is also often useful to the forester. The question is whether to sacrifice some accuracy and have a rule which the average man can apply easily, or to be wholly accurate with a complicated formula. Bruce and Schumacher[1] give a table for the International, ¼-inch kerf, with the note, "Values to the nearest 5 b. f.". If this is sufficiently accurate for a text-book, could it not be all right for a rule of thumb? It would seem that the best rule should be reasonably accurate, but preeminently capable of easy, rapid calculation by average foresters.

Sammi's[2] formula for a 16-foot log by International, ¼-inch kerf:

$$\text{B. M.} = 0.8D\ (D-2)$$

should be accurate enough, but is not easily calculated mentally. Gevorkiantz's[3] formula for the same log is:

$$2D(2D/5-3/4)$$

This is accurate, but even harder to figure swiftly. Both of the above can be calculated easily on paper, but the forester who forgets his log-rule note-book probably forgets also his pencil and paper.

Any number of rules of thumb can be devised, but to make one which is sufficiently accurate for logs of all sizes admittedly necessitates complication. It might be better to follow Becton's[4] suggestion and use two. The following rules are suggested for a 16-foot log by International ¼-inch rule:

I. For log diameters up to and including 13 inches:

$$(D+(D/2-2))\times D/2$$

II. For logs 14 inches and above:

$$(D+(D/2+2))\times(D/2-1)$$

These are somewhat more difficult for uneven diameters than even, but they do away with some complication of calculation. To illustrate the simplicity and accuracy of the first formula, let us take a 10-inch log. Substituting into Formula I, we have $10+3\times5$, or 13×5, which is 65 board feet, the same figure as given by Bruce and Schumacher. In the second case let us take an 18-inch log. Substituting into Formula II, we have $18+11\times8$, or 29×8, which is 232; while the value given by the above reference is 230.

In regard to the use of different log rules, is the time not right for the foresters as a group to get behind one and

[1]Bruce, Donald, and F. X. Schumacher. Forest mensuration. McGraw-Hill, N. Y., p. 350. 1935.
[2]Sammi, John C. A rule of thumb for log scaling. Jour. For. 34:181. 1936.
[3]Gevorkiantz, S. R. Rules of thumb for log scaling. Jour. For. 34:593. 1936.
[4]Becton, W. R. A rule of thumb for the Decimal "C" log rule. Jour. For. 34:110. 1936.

urge its adoption by states as statute rule? It would appear that the one which approaches closest to mill tally under good sawing conditions should be chosen. It is probable that few foresters will argue for the Doyle, and while the Scribner is better, it still seems to be an unsatisfactory compromise between the Doyle and the International. Would it not be better to unite behind the last-named than to establish the Scribner and then be forced to change later to a better one? It is possible that we should work harder for a cubic content rule, but if not, then let us omit at least one hurdle and unite on the International.

RICHARD D. STEVENS,
University of Arkansas.

FORESTRY PROGRESS IN HAWAII

The report of the Territorial Forester of Hawaii for the calendar year 1935 shows that about one-fourth of the land area of the Islands is included in 64 forest reserves, totaling 1,027,299 acres but 35 per cent privately owned.

Wild animals are the greatest destructive agency; in 1935 forest rangers and hunters reduced their number by killing off 6,428 head of sheep, 4,767 goats, 3,307 pigs, and 38 cattle. Forest boundaries are being fenced against grazing, and at the close of the year 1935 only 19.77 miles of boundary fence remained to be built to give complete protection to all forest reserves.

Fire protection is maintained at a high degree of efficiency. Twelve fires during 1935 were confined to 249 acres. As a further aid to fire protection, 190 miles of foot, horse, and truck trails were built and 215 miles were maintained.

Considerable advance has been made in forest research, principally in tree planting and in the introduction of new species for difficult sites, and numerous permanent improvements have been made at nurseries and ranger stations. Nursery production and tree planting showed gains in 1935 over previous years. Five nurseries distributed 1,731,235 forest trees and 66,755 other plants, and some areas were seeded in from the air. Of 20,553 acres in need of reforestation in 1932, a total of 12,839 had been planted by January 1, 1936. The labor and supervision supplied by E.C.W. was largely responsible for making 1935 an outstanding year. It is estimated that all areas requiring attention can be reforested in four more years of the C.C.C.

ALBERT G. HALL,
U. S. Forest Service.

GERMINATION AND SURVIVAL OF LONGLEAF PINE

On November 29, 1935, at the Louisiana State University School Forest, near Bogalusa, La., six beds 3 x 10 feet were seeded with longleaf pine at the rate of 10 seeds per square foot on cut-over longleaf pine land having scattered seed trees. Three of these beds were protected against birds and rodents and from natural seeding from nearby seed trees. Three were protected only from natural seeding. Adjacent to these, six beds were similarly established after burning the rough. Fire has gone over the area annually for the last nine years, with one or two exceptions.

On December 29, 1935, January 31, 1936, February 25, 1936, March 29, 1936, and April 26, 1936, determinations were made of the seeds which had germinated and the seedlings which had died between tally periods.

RESULTS

On both the burned and unburned areas, there was no germination on the beds unprotected from birds and rodents on or after December 29, 1935. It was impossible to tell whether the damage

was done by birds, rodents, or some other agents. Some of the seed had been carried away, some had been gnawed, leaving only the wings, and some had holes cut in the seed coat and the kernel eaten out.

On the six protected beds on the burned and unburned areas, the results were as follows:

	Unburned Germinated	Unburned Died	Burned Germinated	Burned Died	Total (by month) Germinated	Total (by month) Died
Dec. 29, 1935	138		338	—	476	—
Jan. 31, 1936	153	15	104	46	257	61
Feb. 25, 1936	17	25	3	13	20	38
Mar. 29, 1936	10	35	2	9	12	44
Apr. 26, 1936	—	3	—	3	—	6
Total germinated	318	78	447	71	765	149
Total survived	240	—	376	—	616	—
Per cent survived	75.5	—	84.1	—	80.5	—

On one of the protected beds on the unburned area only two seeds are recorded as having germinated. There was no evidence that rodents had made entrance, but it was observed that many seeds had germinated and immediately been cut off at the ground by cut-worms or some other agents. Similar damage, though slight, took place in the other two beds on the unburned area. No such injury was observed on the burned area. With the data from three 3 x 10-foot beds it is impossible to tell whether the damage of this nature was average, high, or low.

Germination was quicker on the burned than on the unburned area, as would be expected, incident to the greater isolation on the ground free of grass. However, that observation may be in part due to the fact that with the dense rough some seeds that had germinated by December 29 were not tallied until January 31.

On the burned area, the seeds that germinated in December and died later, died in January, with the exception of seven. This may be the result of sudden frost with no protection from grasses. The minimum temperature in January for Bogalusa, approximately 10 miles east of the School Forest, was 19°F., while the average of the daily minima for January was 38.7°F. The minimum for Franklinton, approximately 10 miles west of the School Forest, was 20°F., with the average for the daily minima in January 37.2°F.

Of the total amount of seed on both areas, (not including unprotected beds) 42.5 per cent germinated. Of the total which germinated, 80.5 per cent survived at the end of April, 1936. On the unburned area 35.3 per cent of the seed germinated, and of that which germinated 75.5 per cent survived. On the burned area 49.7 per cent of the seed germinated, and of that which germinated 84.1 per cent survived.

SUMMARY

On the beds not completely screened with wire mesh, some agents, probably birds, rodents, or both, accounted for the total destruction of the seed.

On the protected beds, the germination and survival were higher on the area burned previous to seeding.

On the burned, exposed soil, of the seedlings germinating in December and dying later all but seven died in January.

CONCLUSIONS

In broadcast seeding, high losses may be expected through the destruction of the seed by predators.

Burning of the area prior to broadcasting will increase germination and survival.

Edward G. Roberts,
Baton Rouge, La.

A Study of the Effect of Drought on Trees

The 1936 drought is one of the most serious and widespread the Nation has even experienced. Not only have there been untold suffering by the local residents and terrific losses in crops, but other forms of life over considerable areas are showing the effects of abnormally high temperatures and deficient precipitation. Just how serious some of these effects are remains to be seen.

In forestry and plant ecology, droughts are of considerable significance because of their effects on survival, growth, and behavior of trees and shrubs. Some species or individuals may be killed, others suffer severe injury, while still others may show remarkable ability to withstand the most adverse conditions. In times of severe drought forest plantations suffer severely, especially those composed of species not native to the locality or those badly abused, as by grazing. In addition many native species that have been slowly invading drier sites or localities may be eliminated over large areas.

As information on drought resistance of trees and shrubs is sadly lacking, the present affords an unusual opportunity to obtain data of outstanding value. Consequently, it is hoped that those who are in a position to do so will take notes on the reaction of various plants to the drought. Such information is not alone of scientific interest but has great practical value in many current operations, such as the reforestation program of the C.C.C., cultural operations in the forest, erosion and flood control, etc.

The Forest Service is undertaking the collection of data on the drought damage. In this it is seeking the aid of botanists, agronomists, foresters, meteorologists, and other interested individuals throughout the drought area. Consequently it is desired that anyone with observations on species behavior communicate them to the Division of Silvics of the Forest Service at Washington, D. C. Data are wanted especially on such features as the nature, extent, and character of the damage, the relative resistance of trees growing on different sites, the comparative ability of native and exotic trees to withstand drought, and the nature and extent of the damage to stands or to shade or ornamental trees, shrubs, etc. A questionnaire covering these points has been drawn up to aid observers in reporting the effects of the current drought.

The Stroll Method and the Lane Method of Planting

An article contributed by W. E. Hiley to the April, 1936, *Quarterly Journal of Forestry* describes two methods of planting used by foresters in Great Britain and known respectively as the "stroll" method and the "lane" method. They are designed to achieve economy in clearing brushwood before planting and to insure better growing conditions for the planted trees on coppice areas being converted to conifers. As such, they might apply to similar conversions of hardwood sprout stands in America.

In the stroll method the slash from tops is cut up and laid in parallel rows across the felled area, with centers 10 to 12 feet apart. Rows of young trees are planted along each side of the strip, or at distances of 5 or 6 feet.

The word "stroll" in Devon, England, where the method originated, means rows of hay raked up before hauling. This term was applied to the brushwood rows. Advantages claimed are a saving of cost over that of removing the slash, better fertility, shading the ground, and wind protection.

The lane method is applicable to coppice or sprouts not over 6 feet high.

Here lanes are cut 6 to 8 feet apart, and between them the sprouts are cut back to 2 feet and the slash is laid alongside the lane. After planting with conifers the lanes are kept clear for a year or two, but the sprouts are allowed to grow in the intervening strips, with cleanings when they shade or whip the seedlings. It is successful with fast-growing conifers like Douglas fir or Japanese larch, which soon outgrow the sprouts. Advantages are wind protection, shading of soil surface, oak litter, more rapid completion of canopy and pruning of conifers, and lowered planting costs because of wider spacing.

H. H. Chapman,
Yale School of Forestry.

Erratum

In the sub-committee report entitled "Forest Wildlife Census Methods Applicable to New England Conditions", Journal of Forestry 34:469, the second paragraph read in part:

"A method used during the present year on about 1,000 acres at Petersham was to make a total census, using a bird dog and recording on a type map birds flushed and roosts or tracks seen. . . . The first census of the area was made at the rate of about 200 acres per 8-hour man-day."

The text should have read that the method was used on about 500 acres, and that the census was made at the rate of about 100 acres per day.

N. W. Hosley, *Chairman.*

REVIEWS

Effects of Drought on Oak Forests. By A. C. McIntyre and G. Luther Schnur. *Pennsylvania State Coll. School Agric. and Exp. Sta. Bull. 325. 43 pp., 12 figs. March, 1936.*

In 1927, precipitation in central Pennsylvania was 26 per cent greater than normal for the 20-year period 1914-1934. In 1930 it was 35 per cent below normal. These extremes, occurring a few years apart, prompted a study of drought effects in 1932 by the Pennsylvania Agricultural Experiment Station and the Allegheny Experiment Station of the U. S. Forest Service.

Owing to limitations of time and funds, only a small portion of central Pennsylvania could be studied and only sites showing extreme conditions were sampled. Eight areas, representing four forest types, namely, chestnut oak, hemlock, scarlet oak-black oak, and white pine-chestnut oak-chestnut, and two soil series, DeKalb and Gilpin, were investigated.

A comparison of the basal areas before and after the drought shows that chestnut oak, white oak, red oak, hickory, and red maple suffered less than did scarlet oak, white pine, hemlock, pitch pine, mountain pine, and black oak. The chestnut oak type proved most drought resistant. Crown class apparently had little effect on drought resistance. In general, the stand that survived the drought was poor in vigor.

Among the trees classed as reproduction (less than one inch d.b.h.) the losses by types were: chestnut oak, 30 per cent; hemlock, 80 per cent; scarlet oak—black oak, 7 per cent; and white pine-chestnut oak-chestnut, 13 per cent.

Other factors than precipitation being operative, there was no marked consistency of effect of drought on radial growth of the various species. Conifer growth showed a tendency to lag one year in response to decrease or increase in precipitation, and on some sites the growth of red oak also lagged. In general, red oak was most sensitive to precipitation variation and pitch pine was least sensitive.

The height growth of planted red pine and Scotch pine tended to lag one year behind variations in precipitation. The same was true of white pine saplings under natural conditions, but the growth of planted white pine showed close correlation with precipitation, with no lag.

The methods of making this study—the selection of extremes and the inclusion in the data of two years' growth after the drought—may be subject to some criticism. Extremes, although they exaggerate the general effects, nevertheless show the trends of response to precipitation and drought.

ALBERT G. HALL,
U. S. Forest Service.

The South Carolina Civilian Conservation Corps Forester. By D. Y. Lenhart. *40 pp. Illus. State Commission of Forestry, Columbia, S. C. 1936.*

From the inception of the Emergency Conservation Work movement, foresters have sought ways to direct the interest of the members of the Civilian Conservation Corps toward an intelligent un-

derstanding of forestry. Strangely enough, considering the abundance of elementary primers, outlines, and pamphlets on forestry, those who studied the situation found that actually there is very little printed matter available, and that that little is in many respects inadequate.

Writers of college text-books, for example, could not be expected to know the least common denominator of intelligence, so to speak, in the C.C.C. Numerous types of lessons have been prepared, but unfortunately they often are defective in one of two respects; they are either too general in scope or too narrow. To illustrate: the set of lessons in elementary forestry prepared for C.C.C. enrollees in Pennsylvania is obviously unsuited for the instruction of enrollees in South Carolina.

The need for simple and concise instruction in local forest conditions is no better illustrated than in this latter state, where some 15,000 boys have passed through the camps. The bulk of their forestry work has been on privately owned land and has been largely construction improvements of an engineering rather than of a forestry nature. The problem presented itself, should the opportunity be lost to provide them with forestry instruction?

This bulletin gives the answer. And a very effective answer it is. In six well illustrated and simply written chapters the author has compiled a most comprehensive digest of forestry information.

Each chapter is broken down into short and easily understood subjects, and concludes with suggestions for discussion. The paper is heavy, the type is large, and all together it is a fortunate example of good arrangement combined with good printing.

Most foresters agree that one of the urgent needs in the C.C.C. is sound training in vocational forestry, particularly if and when the Corps becomes a permanent institution in our American forests. This publication helps focus attention on this need, but, further than that, it suggests the kind of instruction likely to prove most effective.

HENRY E. CLEPPER,
Pennsylvania Department of Forests and Waters.

Selection of Lumber for Farm and Home Building. By C. V. Sweet and R. P. A. Johnson. *U. S. Dept. Agric. Farmers Bull. 1756. 45 pp., 16 figs. Government Printing Office. Washington, 1936. Price 5 cents.*

For wood to maintain the position it has won as a major component of rural construction, it is necessary that the builder and home-owner be educated in the selection of lumber for its various uses. In many instances it has lost favor because the right species or the right grade of the species has not been chosen for a specialized use. High costs and short life of wood in construction may often be traced to its misuse.

In this new manual the authors, engineers of the Forest Products Laboratory, have prepared a guide to the selection of lumber for farm and home building. Under 28 headings ranging from exterior trim, flooring, and paving to silos, tanks, vats, troughs, and windmill and well platforms the elements of construction are grouped. The usual requirements and the woods and grades best adapted to economical and efficient use are listed for each.

Forty-four commercial woods are classified according to working and behavior characteristics, strength properties, surface characteristics of common grades, and distinctive uses. The properties and characteristics are described in short, pithy paragraphs, and a brief discussion of lumber grades and sizes is included.

In a section on standard lumber items

usually carried in retail yards, and in another on important points in construction and maintenance, the home-builder is given an outline of knowledge which normally is gained only after considerable experience in purchasing and building. Numerous figures compare good and poor construction practices from the standpoint of reducing failure caused by decay.

The bulletin is recommended to home-owners and builders as the conclusions of men who have studied and tested woods under varying conditions of service over a period of many years.

Albert G. Hall,
U. S. Forest Service.

Hardy Shrubs for Landscape Planting in Michigan. By C. P. Halligan. *Mich. State Coll. Agric. Extension Bull. 152, revised. 84 pp. Illus. 1935.*

The forest administrator who recognizes as one of his responsibilties the production of food for wildlife, but who lacks knowledge of or reference material on the silvics of the food-producing shrubs, will welcome this bulletin as an important addition to his library.

Although the text and descriptions of the plant materials, as the title indicates, relate to horticultural properties, nevertheless in the descriptive matter and tables information is presented concerning soil moisture, soil texture and fertility, light requirements, growth characteristics, and cultural directions for 25 native and 17 exotic species, hardy in Michigan, that are attractive to wildlife. Actually, however, all these shrubs are hardy from Maine to North Dakota, and south to Oklahoma and North Carolina. Therefore, the information given has a wider application than perhaps was originally intended.

This information can be utilized to indicate the choice of site and species for a wildlife food-planting program, with either wilding or nursery stock. Furthermore, it will guide the design of forest cultural treatments having as their aim the improvement of forest composition and the production of wildlife food by the forest shrubs, as well as wood production by timber trees.

The recommendations concerning the technique of lifting, handling, and planting nursery-grown or wilding stock indicate, as one would suppose, that considerably more care is required in landscape planting than in establishing the ordinary forest plantation.

John C. Kase,
Pennsylvania Department of Forests and Waters.

Artificial Reforestation in the Southern Pine Region. By Philip C. Wakeley. *114 pp., 23 figs. U. S. Dept. Agric. Tech. Bull. 492. 1935.*

A need has long been felt for information of the type contained in this bulletin, but the need has become especially urgent during the last few years since reforestation activities in the South have increased by leaps and bounds. The basic information was collected by the author during 10 years' study of the subject.

Artificial reforestation with the native southern pines is stressed because most of the abandoned farm and cut-over lands are much better adapted for these than for any other species. The author discusses the collection, extraction, storage, testing, and treatment of seed to stimulate germination, nursery establishment and practice, and the establishment and care of plantations.

The bulletin is written in a clear, concise, and very readable style and on the whole gives information applicable to the southern pine region from North

Carolina to eastern Texas. However, owing to the variation in conditions throughout this region, the author has not always been able to recommend, as specifically as is desirable in such a handbook, the best methods to use under particular local conditions.

Wakeley very logically emphasizes the fact that the greatest care should be used in the selection of a nursery site and in its lay-out and preparation. In the past many a nurseryman, particularly in the West, has had much needless grief because of poor selection in nursery sites. The material on seed storage is very well presented. Another good feature of the bulletin is the recommendation that seed testing be placed on a thoroughly sound statistical basis.

Chemical weeding by means of treatment with zinc sulphate, which has given good results in other regions, gave unsatisfactory results at three different nurseries. The author most appropriately recommends against the use of chemical weed killers until experiments at each particular nursery prove that the chemicals can be used successfully with reduced weeding cost and without injury to the soil over a period of years.

Damping-off is not as serious in the South as in the North or West.

The grading of nursery stock is strongly advocated, and justifiably so. For example, Wakeley states that studies of longleaf pine in both experimental and commercial plantations indicated that high-grade seedlings not only suffered less from the brown-spot fungus and silting-over but also began height growth at a younger age than did low-grade seedlings. Another sensible recommendation is the judicious use of two or more species in mixtures, a policy which is firmly taking root in European practice where satisfactory mixtures are possible. Although the author suggests mixing slash pine and longleaf pine by alternating 3 rows of the one species with 3 rows of the other, the inference is left that single-row mixtures of other combinations of species are permissible. Experience in the Carolinas indicates that alternating bands, each of several rows, or even planting checker-board-wise is much better than single-row alternations. In single-row mixtures one species usually succeeds and the other largely fails.

A most reasonable recommendation is that the best species to plant on a given site ordinarily are the same as those which comprised the bulk of the original stand.

Some of the generalizations are too sweeping. For example, the author states that longleaf pine or slash pine should be planted instead of loblolly pine or shortleaf pine in localities where damage by the Nantucket tip moth is severe. He apparently overlooked the fact that we have in North Carolina a large area beyond the natural range of either slash pine or longleaf pine on which it would be inadvisable to plant either species except experimentally. Furthermore, although tip moth injury may be severe for about 5 years following planting, the plantations, especially those of loblolly pine, soon grow beyond the height of appreciable injury.

Even though it has become increasingly customary to plant southern pines without any direct preparation of the planting site, Wakeley advises for some soils and in some cover types the plowing of shallow furrows in which to set the trees.

A unique feature of the bulletin consists of a concise tabulation of important nursery operations, aranged in chronological order, along with the dangers most likely to be encountered. This tabulation should be very helpful, especially to the relatively inexperienced southern nurserymen. It emphasizes the frequently made statement that the nurseryman must be constantly on the alert for the first inconspicuous signs of

drought or heat injury, insects, fungi, or other possible sources of injury.

The otherwise high quality of the publication is slightly depreciated by the occasional appearance of somewhat loose expressions, such as "longleaf" for "long leaf pine", "loblolly" for "loblolly pine", and "forest school" for "forestry school", permissible in conversation but hardly most desirable on the printed page of a technical publication.

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Biomathematics—Being the Principles of Mathematics for Students of Biological Science. By W. M. Feldman. With Introduction by Sir William M. Bayliss. *Ed. 2. XVIII + 480 pp. Illus. Charles Griffin & Company, Ltd., London, and Lippincott & Co., Philadelphia, 1935. Price $10.*

This book has two objectives: First, to acquaint the average investigator with sufficient basic mathematics to enable him to follow more intelligently modern research technique in the biological sciences; and second, to present those principles of mathematics that will help him more fully to interpret the results of his experiments.

The text begins with a concise review of the main principles of mathematics up to and including calculus. A large portion of the book is devoted to illustrating the application of mathematics and statistical methods to biological problems. The chapters on "Fourier's Theorem" and on "Estimation of Errors of Observation" deserve especial mention. The concluding chapter deals with the application of statistical methods to problems in biology.

This book could be more appropriately entitled "The Scientist's Mathematics Handbook", because it is probably the only book that includes in one volume both the principles of mathematics and the mathematics of statistics. It is sufficiently elementary that the average investigator can easily master its contents. All research workers should find it an invaluable reference work, especially those who wish to review the mathematical basis of statistical technique.

Robert T. Anderson,
Lake States Forest Experiment Station.

Trees and Tree Planting. By Parker O. Anderson. *X + 95 pp. Illus. Webb Publishing Co., Saint Paul. 1936. Price 50 cents.*

Probably one of the most effective means of spreading the gospel of forest conservation and of making the general public tree-conscious is the effort made by the states to interest land owners and civic groups in trees and tree planting programs. This booklet, by the Extension Forester of Minnesota, is another contribution to the growing literature designed to stimulate interest among potential tree planters.

The first part of the book describes the tree and the factors which influence its growth, the selection of trees for planting, the planting operation, the protection of trees, and tree surgery. Part II contains short descriptions of 48 common forest trees of Minnesota and the Lake states, and is illustrated with pen and ink sketches by Mrs. A. E. Hoyle, whose drawings have been used in similar publications in a number of states.

Written for farmers and for boys' and girls' clubs, it will serve as an introduction to tree study and as a guide to the identification of the more common trees.

Albert G. Hall,
U. S. Forest Service.

Handbook of Erosion Control Engineering on the National Forests. Prepared by U. S. Forest Service, Division of Engineering, T. W. Norcross, Chief. *89 pp., 72 figs., Gov. Printing Office, Washington, D. C., 1936.*

This handbook was written jointly by E. W. Kramer, Regional Engineer, Region 5, A. L. Anderson, Engineer, and M. B. Arthur, Hydraulic Engineer, in the Washington office of the Forest Service.

This is the first erosion control handbook designed primarily for use in the National Forests. It therefore emphasizes the measures which apply to comparatively undeveloped types of land rather than those for agricultural areas. Other handbooks and manuals have previously been prepared for specific areas by the Soil Conservation Service and by the T.V.A.

The chapter headings indicate the scope of the book. They are: The erosion problem on National Forests; erosion control measures; hydraulics of erosion control; gully structures; estimated cost of obliterating a gully; soil-saving and debris dams; miscellaneous structures.

Engineering structures in erosion control are designed primarily for the purpose of stabilizing the site and checking the rapid movement of soil and water on eroding areas so that a vegetative cover can be established. The control of sheet erosion is, by and large, a problem of restoring such a cover. In the case of erosion on grazing land, it is often necessary to have engineering structures control the run-off so that the water table may be raised and the pasture grasses reestablished. On these lands permanent structures, such as masonry check dams, rock spreaders, and stream revetment work may be justified. Where the area to be controlled is to be restored to timber, more temporary structures are permissible. Various types of control measures are ably discussed in relation to several erosion control projects.

Numerous figures scattered throughout the text illustrate various control structures and the results obtained. The details are excellently shown, and the designs agree for the most part with the latest developments in erosion control technique.

It is surprising, however, that the authors did not lay stress, both in the text and in the sketches, on the construction of a "stilling" basin in the aprons of check dams. Such basins serve a very definite purpose in slowing down the water and can very easily be provided by erecting a low rock wall in the apron at a distance from the face of the dam equal to two-thirds of the height of the dam at the spillway notch. The apron itself should be extended a foot or so beyond this "hydraulic jump" and the end of the apron should be protected from undercutting by having a toe log with brush matting. If the check dams are built so that the apron from one dam is level with the spillway notch of the dam below, this stilling basin may not be necessary. It is essential if there is to be any gradient between dams. The churning action of the water after it leaves a dam without a stilling basin and a hydraulic jump is well illustrated in Figure 48.

Figures 48, 49, and 51 illustrate check dams with the wing walls higher than the banks of the gully. This practice has been found undesirable in the Tennessee Valley, for it tends to cause excessive flood waters to cut around the dam and into the banks if the spillway notch has not been properly designed. If the run-off is carefully calculated and the spillway notch designed properly, there should be no need for extending the walls above the gully banks.

It has been the general experience of erosion control engineers, and this is

borne out by the authors, that no hard and fast specifications can be laid down for erosion control structures to fit conditions in all parts of the country. There are so many variables, such as soil, slope, rainfall, and cover that each job presents a separate problem, and a combination of control measures must often be worked out for a single job. This handbook will call the attention of the Forest officer to the various types of structures which can be used in gully and erosion control work. He will then have to decide which type of structure best fits the conditions with which he is faced. He should not lose sight of the fact, however, that one of his major problems is to prevent the formation of gullies and the occurrence of erosion of his Forest, and should so handle the watersheds under his administration that their water absorptive capacity will be protected.

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